Gentrification of Neighborhoods in New York City after Hurricane Sandy

: Focusing on housing market change of three borough region by zip code area

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Abstract

While natural disasters impact on people regardless their economic capacity, vulnerable people are affected more than others. By exacerbating housing market problems, housing recovery after the natural disaster events reveals the inequality issue in post-disaster planning. Cue to the failure of the institution, victims from disasters experience both the inflation of housing market stemming from the gentrification after the disaster and the depreciation of property value from risks of future disasters.

The study examines the property value changes of three boroughs, Brooklyn, Queens and Staten Island using Inverse Distance Weight Interpolation method. Thereafter, by using geographically weighted regression (GWR) model, the research finds out the impact of the Sandy on housing market dynamics in New York City; the impact of Sandy is relying on the location and the situation of both individual property and neighborhoods, especially the proximity and the accessibility to the urban core such as Manhattan and New Jersey. The purpose of the study is to provide the insight for planners and policy makers with the clue to device a reasonable and efficient housing recovery plan by examining the correlation between housing market change and disaster issue.

Keywords: gentrification, hurricane Sandy, housing market dynamics, post disaster planning, housing recovery, inverse distance weight interpolation, geographically weighted regression analysis

1. Introduction

On October 2012, a late-seasonal hurricane, Sandy, hit the coast of Northeastern United States. The Sandy was recorded not only as the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season, but also as the second-costliest cyclone hit the United States since 1900 (Blake et al., 2012). The New York Times reported that 60 million people across 24 states experienced a range of storm effects at varying intensities, including wind, rain, flood, coastal surge and blizzard. Sandy is blamed for damaged 200,000 homes and the cost has been estimated at $50 billion (Walsh et al., 2012). The effects of the storm on fragile infrastructures produced power outages for 8 millions residents: flooded New York City's subway system and East River tunnels, set off a major fire that destroyed 111 housing units in Queens, disrupted communications, closed three major airports in New York MSA, John F. Kennedy, La Guardia and Newark airports and caused 113 deaths in the United States[1]. In New York City, 44 people lost their lives due to the Sandy. As of January 2, 2013, 62,230 of residenstial properties were damaged by Sandy (New York City, 2015).

However, on the contrary to the perception of people that the Sandy is unprecedented holocaust, the number death is not that much massive. Even though the fact that the Sandy was unprecedented tragedy is never changed, comparing with its enormous damages on Northeastern region, the death toll is relatively smaller than those of other massive catastrophes, such as 2004 Indian Ocean earthquake and tsunami (280,000 deaths), 2010 Haiti Earthquake (160,000 death) and so forth.

Historic Transition of Damage Aspect from Nature Disaster

As times passed, the damages of the disasters on the built environments have also changed significantly due to the changes of urban environments. There is a statistically strong correlation between the impacts from disasters and time; whereas the number of the death from disaster issues have decreased gradually, the economic loss from the disasters tends to have increased. The data from Centre for Research on the Epidemiology of Disasters supports, or CRED, suuports the idea. There are two reasons explaining the tendency: the increase of population density stemming from the urbanization and the improvement of the forecast technology. The urbanization makes people to use land more compactly than before the urbanization. Consequently, the number of affected urban residents and the building structures in urban area is larger than the rural area even if the damage radiuses of both regions are exactly equal.

The improvements of forecasting[2] and other technologies preparing disaster events also have

1. Assessing the Damage From Hurricane Sandy. (2012, October 29). New York Times. Retrieved February 24, 2015, from http://www.nytimes.com/interactive/2012/10/30/nyregion/hurricane-sandys-aftermath.html

2. Forecasting is different from prediction in regard of its short-term prediction in terms of the magnitude, location,

influenced preventing massacre, so far. For example, in terms of economic aspect, the damage from hurricane Galveston in 1900, as known as the deadliest hurricane in the United States history, is considered as simlar as that from Katrina in 2005. Damages from both disasters were $104.3 billion and $113.4 billion, respectively. However, the damaged of human lives were absolutely different. Whereas the death toll from the Katrina was 1,836, the loss of lives from the Galveston in 1900 was between 6,000 and 12,000. The Weather Bureau forecasters had no way of knowing where the Galveston was or where it was going. At the time, they discouraged the use of terms such as tornado or hurricane to avoid panicking residents in the path of any storm event. Consequently, the one of significant reasons why the Galveston became the deadliest tragic in American history was the failure of forecasting the route of the Galveston and broadcasting the catastrophe (Frank, 1900). The improvements in tracking and forecasting hurricanes from the 20th Century have been very significant. Thanks to the improvements, the loss of lives from the catastrophes has reduced dramatically. However, less death but still significant number of affected population combining with the high population density of urban area due to urbanization brought another urban issue: inequity during disaster process.

Disaster and Housing Inequity

There is no such thing as a natural disaster[3]. Even if disaster impacts on a specific area regardless its socio-economic characters, the level of damage that residents in the area varies on their economic capacity. Prior experience show that the pre-disaster urban situtions determines the post-disaster recoverty crisis. Where household budgets were devoted to high housing costs, they will be less able to prepare for disasters with material goods and savings. Where affordability was a problem before the storm, it will be exacerbated by housing loss (Bate, 2006).

The recovery of housing in the aftermath disaster is fully related to the individual's vulnerability. In the United States, Americans have relied on a combination of private insurance and very limited government assistance to recover from the occasional housing destruction metered out by nature (Bate et al. 1987; Bolin et al. 1983; Comerio 1998; Quarantelli 1982). Whereas the recoveries of public infrastructure and urban system are driven by public realm, the market primarily drives the repair, rebuilding or replacement of housings after natural disasters.

Of course, public realm also put several efforts to recover the housing after disaster. The problem is most of attentions to dwelling of the victims are paid to the earlier processes, such as

date and time of an event.

3. This phrase is also a title of a book edited by Gregory Squires and Chester Hartman, which is the comprehensive citirical book on the catastrophic impact of Katrina on New Orleans. In this book, authors argue that the impacts of the Katrina was uneven due to the unevenness of race and class in New Orleans pre-Katrina.

emergency and temporary sheltering (Lindell et al. 1991)[4]. On the contrary, permanent housing is a topic almost totally ignored at local community level disaster planning in the United States, and perhaps understandingly so (Quarantelli, 1995). In addition, disaster housing has been driven by the assumption, by both FEMA and its state partners, of a temporary, short-term mission in order to respond to fleeting negative media reports rather than the design of comprehensive policies (McCarthy, 2011). Until 2006, for instance, even FEMA limited its financial or direct assistance for permanent housing to only insular area outside the continental United States and in other remote locations (McCarthy, 2011). Consequently, the primary funds for housing recovery come from private sources, which include personal savings, loans, and insurance, with the latter being the most important (Comerio, 1998; Peacock et al. 2006; Wu et al. 2004). The problem is that the dependence on the private funds can bring the inequity issue of disaster housing.

In this situation, the fluctuation of housing market after natural disaster is crucial to low- and mid-income households due to the lack of long-term housing provision plans from public realm. The absence of social safety net and the tendency relying only on the market mechanism make economically vulnerable population receive whole impacts from housing market fluctuation after the disaster, directly. For instance, skyrocketing rent decreases of affordability by makeing renters pay more proportion of their income as housing costs. On the contrary, the recession of housing market plummets housing value. The deflation affects mid-income households more because of the increase of burden of paying mortgage. Moreover, the recession also impacts on the renters because the rent is increasing during the recession since potential homebuyers postpone buying home anticipating that the housing price will fall more.

Unfortunately, since the Sandy is very recent disaster event, the study about housing market change of New York City after the Sandy is rare. Besides, since previous literatures have conflicting opinions on the subject of the correlation of disaster and housing market. Therefore, examining the housing market change after the Sandy is meaningful since it will provide planners and policy makers with the clue to device a plan for New Yorkers.

In this sense, the purpose of this research is figuring out whether hurricane Sandy have gentrified the New York City, especially three Boroughs, Brooklyn, Queens and Staten Island, which were affected severely by the Sandy. The research shows the housing market change after the Sandy. Thereafter, the study also figures out the correlation between housing market changes in three boroughs after the Sandy and both natural and socio-economic characters of the affected areas with quantitative analysis. Lastly, the study provide meaningful insight providing planners and policy makers with the clue to device a reasonable and efficient housing recovery plan for New

4. In 1980s, E.L. Quarantelli expanded the scope of post disaster housing by distinguishing between four different terms, namely: emergency sheltering; temporary sheltering; temporary housing; and permanent housing.

Yorkers by examining the correlation between housing market change and disaster issue.

2. Literature Review

Explanation of Gentrification

In order to verify the correlation between the disaster and the gentrification, clarifying the definition of the gentrification should be settled first. Generally, a certain area is considered as gentrified, where its property market price, income level and demographic composition are changed positively. It also refers to the transition of property markets from relatively lower value platforms to higher value platforms under the influence of redevelopment and influx of higher-income residents, often with spatial displacement of original residents and an associated shift in the demographic, social, and cultural fabric of neighborhoods under its influence (Torrens et al, 2007).

The issue is the indicator examining the signal of gentrification because there are a variety of indices indicating gentrification. According to previous literature, generally there are four major explanatory emphasises of gentrification: demographic transition, economic characteristics change of neighborhoods, the value of urban amenity and housing market dynamics (Ley, 1986).

Among those explanations, indicators of both demographic transitions and changes of neighborhoods' economic characteristics are not sufficient to show the evidence that a certain region is gentrified. Freeman (2005) argues that gentrification is not necessarily associated with displacement of low-income households. He studies a sample of US neighborhoods using the geo-coded version of the Panel Study of Income Dynamics (PSID), which identifies census tract of residence. As a result, he finds the fact that gentrifying neighborhoods actually experience a $4,000 decrease in median household income during the 1990s.

The research conducted by Bostic and Martin (2003) also supports the idea that gentrification does not always imply a race-based neighborhood transformation. They uses aggregate data to test whether black homeowners were associated with gentrification in the 1970s and 1980s. They find that the presence of black homeowners was possibly correlated with in 1970s but not the 1980s. They conclude that the gentrification is not the issue of race based neighborhood change but rather a 'minorities moving in, minorities moving out' transitional process.

On the other hands, the urban amenity can be a reseonable explanation of the gentrification since urban amenity is a motor determinant in the location of revitalizing districts. A survey of 57 gentrifying American neighborhoods showed that 87 percent of them contained some distinctive landscape amenity (Clay, 1979). In this context, several indicators of urban amenity, such as social indicators index, resident satisfaction, the cultural amenities per certain number of population and so forth, can be explanations of gentrification and previous literature find the strong correlation between the urban amenity and gentrification (Ley, 1986)

Lastly, a majority of literatures choose the housing market dynamics as an index of the gentrification. Indeed, the most systematic are housing market hypotheses, where both demand- and supply-led arguments have been developed (Ley, 1986). Among the rich literature on the gentrification developed different theoretical explanations of the phenomenon, the most influential and path-breaking contribution is represented by the rent gap theory (RGT) of the Marxist economist Smith (Diappi et al. 2008). According to Smith, the rent gap is defined as the gap between the actual capitalized ground rent (land value) of a plot of land given its present use and the potential ground rent that might be gleaned under a “higher and better” use. Adopting his argument, it is possible to assume that a certain neighborhood is gentrified when the gap between current value of property in the neighborhood and potential value is larger than certain amount of threshold.

Among these four categories, this study adopts housing market dynamics (especially, rent gap theory) as an explanation of the gentrification of the affected area. Firstly, as mentioned above, both demographic transformation and economic index is losing validity to examine the gentrification. Of course, even if the urban amenity also can be a reliable evidence of gentrification, there are several restrictions to accumulate data examining the urban amenity since the Sandy was happened only in 2012. Since the term of three years is too short to build sufficient number of new urban amenities in the affected area, it is difficult to evaluate the satisfaction of the residents in the area due to the urban amenity.

On the contrary, housing market dynamic is the most appropriate index measuring gentrification relatively in short-term period. Housing market is very sensitive to the socio-economic changes of the area. According to the housing market change in New Orleans Metropolitan Area, Louisiana (NOLA), after the hurricane Katrina, both rent and housing price reacted to the impact of the Katrina, both immediately and substantially. In 2006, when the Katrina hit the region, the American Community Survey reported 22.89 percent increase for housing prices and 24.26 percent increase for rent in the region in one year. Comparing with the fact that only 12.85 percent and 6.32 percent increased for housing and rent, respectively, in the one year before the Katrina, the response of housing market prices to the Katrina supports the idea that the housing market is very susceptible to the both natural and socio-economic changes of the market area.

Correlation between disaster and housing market change.

Generally, previous literatures come in two different voices about the correlation between disaster and gentrification: 1) the affected areas after the disaster event expereince the recession of housing market due to the risk from the natural hazard; 2) the affected areas after the disaster events are gentrified due to the imbalance between supply and demand of housing units. In spite of their reasonable evidences based on the empirical cases, the conclusions of both main streams of researches are contrary. This section briefly summarizes the arguments of both two different literatures.

a. Disaster causes the recession of the housing market in the affected area

Plenty of researches conducted studies figuring out the correlation between disaster and housing market changes based on DND (difference in differences) Hedonic valuation models. Those researches, using Hedonic modeling, estimated that the sales prices of houses in/near the affected area would be decreased. The researches have documented the price reduction from location in a flood plain and compared the price reduction with the capitalized flood insurance premiums (Shilling et al., 1985; MacDonald et al., 1987; Donnelly 1989; Speyrer et al., 1991; Harrison et al., 2001) [5].

Bin et al. find significant price differentials in Pitt County, North Carolina, after consecutive major flooding events on eastern North Carolina[6]. Especially, The study assumes that both sellers' and buyers' growing perceptions of floods' risk cause the decrease of property value. According to the study, the discount became more prominent in the period immediately following Hurricane Floyd, increasing to $13,137 whereas the price discount disappeared approximately 5-6 year after the Hurricane (Bin at al., 2013).

Hallstrom et al. also find that at least 19 percent decline in property values in Lee County, Florida, due to the hurricane Andrew in 1992. The researches focuses on near misses areas that could have been impacted but were lucky for a specific event. The research finds that the housing values of the near-misses areas decreased as well as those of directly impacted area. The study diagnoses that the recession of the near misses area was due to treating the hurricane's information as leading to updates in homeowners' risk perception (Hallstrom et al., 2004).

Previous literatures argue that not only hurricanes', but also earthquakes' risk could also have a negative impact on the housing prices. In their findings of housing values changes after earthquake events in Japan, Naomi et al. argue that the price discount from locating within a quake-prone area was significantly larger soon after earthquake events than beforehand. Conducting the DND analysis, they find that the post-quake discounts for property values within quake-prone areas more than doubled comparing with pre-quake values. They conclude that the affected areas underwent the housing market deflation because the disaster events evoked the risk of earthquake in the quake-prone areas, which had been underestimated initially (Naoi et al., 2009).

5. A common finding in these studies is that location within a floodplain

6. Amounting to 5.7% decrease after Hurricane Fran and 8.8% decrease after Hurricane Floyd.

b. Disaster causes the increase of the affected area

Previous researches, especially focusing on the hurricane Katrina's case, argues that disaster events stimulate the gentrification of the affected area and as a result the both housing value and rent increase. Furthermore, they also insist that the change of housing market is problematic since it hinders low- and mid-income households from returning to their living foundations due to the inflation of housing market.

In case of Katrina, NOLA's housing market change is absolutely distinct from that of Pitt County's. Vigdor argus that both housing and rent prices in the affected area increased after the hurricane Katrina and the return to pre-2006 housing price levels seem unlikely. In 2006, the ACS reported a median value of \$208,500 for houses in Orleans Parish, a 59% increase in two year. Median rent rose to \$838, a 48% increase in the same time period. He argued that this is because the proportionate reduction in the housing stock exceeded the reduction in population, according to Census estimates. In other words, since the reduction in supply exceeded the reduction in demand, the price of housing of housing in New Orleans rose dramatically in the hurricane's wake (Vigdor 2008).

Interestingly, the research of housing market change due to the hurricane Andrew also argued that disaster events cause the increase of housing value. Zhang et al. found that the average appraised values of single-family residential buildings are increased. According to the research, the appraised fell to \$28,506 following the hurricane in 1993. However, by 1994, 17-22 months after the hurricane, the value was restored the average housing value before the hurricane. Moreover, theses values rose again in 1995, and by 1996, the average appraised value was \$68,324, an increase of 14.9% over the 1992, when the hurricane Andrew had occurred. This result is absolutely conflict the implication of the research of Hailstorm et al, above, which argued that the Andrew have a negative impact on the housing market in the affected area.

In sum, the impact of disasters on housing market in the affected neighborhoods is varying case by case. Even impact on the housing market by an identical disaster event can be observed and interpreted differently, depending on the research methods. Therefore, it is very difficult to theorize and to generalize the correlation between the disaster and the housing market. Previous literatures show that the impact on a certain market should examine case by case and elaborately designed research is necessary to scrutinize and predict the market change.

3. Data and Methodology

Study Area

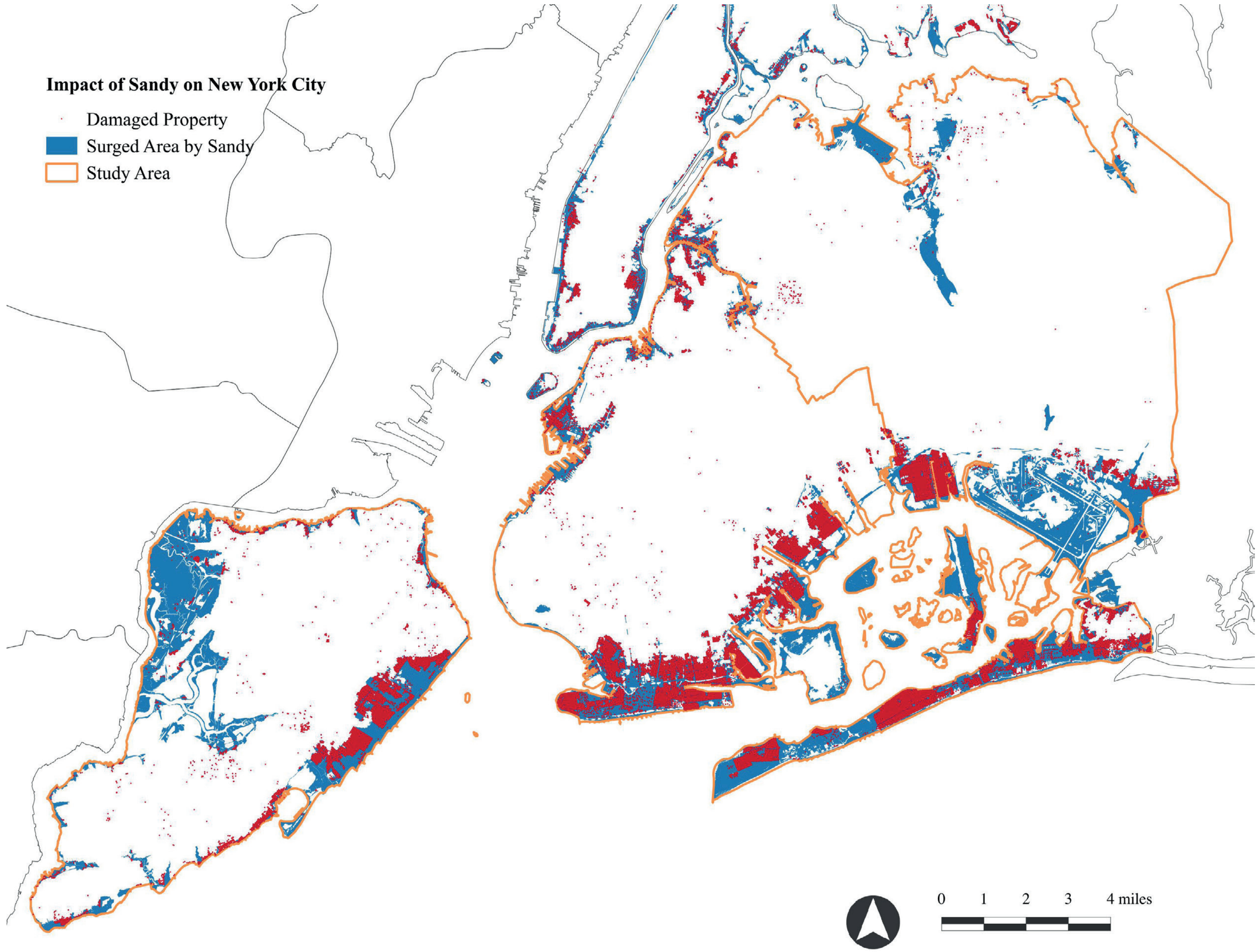

Figure 1. Impact of Sandy on Study Areas
Data Source: FEMA

Among Five boroughs in New Yok City, Sandy impacts in Manhattan and Bronx were much more limited than other three boroughs, Brooklyn, Queens and Staten Island. According to Build It Back Program of New York City, only 30 and 236 property owners in Manhattan and Bronx applied to the program where 6,212, 9,134 and 4,602 of owners in Brooklyn, Queens and Staten Island applied to the program. Considering the impacts of Sandy on sub housing markets in New York City, the sutdy sets top three boroughs, Brooklyn, Queens and Staten Island as study areas to examine the correlation between the Sandy and housing market changes.

Housing Market Change Examination

a. Housing Market Indices

Housing market dynamic analysis of the target areas with housing market indicators is prevalent to evaluate the gentrification since it makes possible to quantify the socio-economic changes of the area with housing market indices. Adopting the RGT of Smith, it is reasonable to argue that examining the gap of the assessed property values (before the Sandy) and the anticipated future property values (after the Sandy) in certain areas indicates the gentrification of the areas.

Since examining housing market change is the key of this study, it is necessary to make a deliberate choice of the data of the housing market change. There are a variety of indices and data examining the housing market changes of various area level, from nation level to individual housing units: Case-Shiller index, Zestimate index and Property of Assessment Roll Data.

Case-Shiller index is the most extensively used housing index for the housing market change evaluation. The benefit of Case-Shiller index is that it provides consistent constant-quality price indices for localized areas within a city or metropolitan area over long periods of time (Guerrieri et al., 2013). Moreover, the methodology was a significant improvement over the more conventional median sale price as it looks at the price change between repeats sales of the same home versus just looking at the median sale price of homes sold in a given period of time. The median sale price is heavily influenced by the type of homes that are selling at a given time, making it a less than ideal measure of home price levels. However, the index is based only on the sample of homes that have sold at least twice that means serves to exclude all new construction. Considering the existence of newly constructed units after the Sandy is important to examine the housing market change, the exclusion of all new constructed building as samples is crucial. Moreover, since the smallest area unit level is zip code area, it is difficult to examine the detailed housing market change variances in the same zip code area.

Zestimate index, provided by Zillow.com, the online real estate database, is an estimate for a home based on a range of publicly available information, including sales of comparable houses in a neighborhood. Zillow.com calculates the Zestimates of not all but some of individual housing units and release them to public. Since Zestimate is carefully estimated index based on both statistical and empirical grounds, it is useful to observe the trend of a speicific area. However, because the accuracy of the index is fully depended on the sample size of target area, it is questionable that the index represent the housing market trends of the area where the sample size is small. Moreover, the accuracy of the Zestimate varies by location depending on how much information is publicly available and by the participation of public[7]. For these reasons, Zestimate is used in this research only for briefly examine the housing market changes of large scale of local markets such as New York Metropolitan Statistical Area and three boroughs.

This research uses the assessed property value (class 1) of ‘Property Assessment Roll Data’ in New York City as an indicator showing the housing market dynamics after the Sandy. The value based on prices of similar properties that sold in neighborhood that the properties are located in. Once the City has determined your market value, it calculates assessed values of the properties. Assessed values are based on a set percentage of market value. Unlike above two indices, the data is calculated by an annual complete enumeration survey rather than sample survey [8]. Therefore, the data reflects the housing market changes more accurately than above two indices. Moreover, the data is technically easier to address than others because the data can easily be combined and joined other data, such as New York City PLUTO (Primary Land Use Tax Lot Output) maps and census data, since each units has BBL code, which other data also have.

In this study, Property Assessment Roll Data in both fiscal year of 2012 and fiscal year of 2016 are used for assessing the presence of a rent gap in the three-borough region. The study address the data of class 1, one to three-unit residential properties, which are dominant types of household in the three-borough region [9]. Among the various values that the dataset provides, the study addresses the ‘assessed total value (including land value)’ as an indicator or the market dynamics. The assessed values are based on a set percentage of market value. For class 1, the assessment percentage is 6% so the market value is multiplied by 6% to arrive at assessed value. The assessed total value plays a role of filtering the outliers of which property values increase extraordinary.

b. Examination of Housing Market Change: Interpolation

Even though the assessed value data were created by complete enumeration survey, there are several missing areas that the data could not cover. An alternative to the establishment of fixed neighborhoods or composite sub-markets involves a more rigorous spatial analysis of property

7. Zillow allows users to check the accuracy of Zestimates in their own region against actual sales.

8. Based on the year of 2014, New York City released 627,832 of properties’ assessed value in target boroughs (215,598, 289,954 and 121,830 properties in Brooklyn, Queens and Staten Island, respectively).

9. According to Property Assessment Roll Data in FY 2016, the shares of class 1 properties of three borough are 67.08 percent, 75.33 percent and 92.40 percent, respectively.

prices in terms of developing terrain of surface models using spatial interpolation[10]. Among the varying interpolation methods, the study uses the inverse distance weighting (IDW) methods for auto collecting the missing areas. IDW estimates the values at unknown points using the distance and values to nearby known points. The weight of each sample point is an inverse proportion to the distance: the further away the point, the less the weight in contributing define the unsampled location.

Based on the interpolated data from New York City, the research maps the property value change by location. Maps examining differences of property value estimations before after the Sandy provides the outline level of housing market dynamics in the affected three boroughs.

Correlation between the Housing Market Change and the Sandy

a. Simple Linear Regression Analysis Model

To discern how both socio-economic factors and natural factors including hurricane Sandy are related to the housing market dynamics in entire three boroughs, the study examined the correlation between housing market change and varying natural and socio-economic factors. The study assumes a regression model of the form:

$$\begin{aligned} Y_{\Delta PROPVALUE} = \; & \beta_0 + \beta_1 X_{BLDGDAMAGE} + \beta_2 X_{EVACU} + \beta_3 X_{DISTMN} + \beta_4 X_{DISTSUB} + \beta_5 X_{DISTLIRR} \\ & + \beta_6 X_{DISTINTER} + \beta_7 X_{BLDGNEW} + \beta_8 X_{BLDGYEAR} + \beta_9 X_{BLDGAREA} + \beta_{10} X_{BLDGVALUE} \\ & + \beta_{11} X_{ZIPDAMAGE} + \beta_{12} X_{ZIPINCOME} + \beta_{13} X_{ZIPBLDGVALUE} + \beta_{14} X_{ZIPRENTVALUE} \\ & + \beta_{15} X_{ZIPPCTRENT} + \beta_{16} X_{ZIPPCTVACANT} + e \end{aligned}$$

Table 1 contains a list of the independent variables which are assumed affecting the housing price changes and their statistic summaries. Largely, the independent variables are categorized into four different groups: damages by the Sandy and risks of future floods; accessibilities to Manhattan; individual building's characters; and neighborhood's characters. Most of the variables and their sources listed in Table 1 are self-explanatory. One variable, however, deserves some discussion: EVACU, the location of the property by evacuation zoning of New York City.

Hurricane evacuation zones are areas of the city that may be inundated by storm surge or isolated by storm surge waters. In the event of a hurricane or tropical storm, residents in these

10. The spatial interpolation techniques use a set of data based on discrete points for sub-areas, then determine a function that will best represent the whole surface which can then be used to predict values at other points or sub-areas (McClusky, 2000).

Variable	Type	Explanation	Source
Damage/Risk			
BLDGDAMAGE	binary	Damged by Sandy, (0 = not damaged, 1 = damaged)	FEMA
EVACU	ordinal	Location of the building by Evacuation Zone (0 = n/a, 1 = Zone 6, 2 = Zone 5, 3 = Zone4, 4 = Zone 3, 5 = Zone 2, 6 = Zone 1)	FEMA
Accessibility to Manhattan			
DISTMN	continuous	Linear distance to the nearest subway station in Manhattan of which subway line is connected to three boroughs (miles)	PLUTO
DISTSUB	continuous	Distance to the nearest subway Station (miles)	PLUTO
DISLIRR	continuous	Distance to the nearest Long Island Rail Road station, only for Brooklyn and Queens (miles)	PLUTO
DISTHIGH	continuous	Distance to the nearest highway interchange (miles)	PLUTO
Building's Character			
BLDGNEW	binary	Building that is newly constructured after Sandy (0 = Constructed and revices before 2013 1 = Conctured or revised after 2013)	PLUTO
BLDGYEAR	discrete	Building contrcution year	PLUTO
BLDGAREA	continuous	Floor area of the building (residential purpose only, square foot)	PLUTO
BLDGVALUE	continuous	Assessed value of the building before Sandy occured, 2012 (dollar)	PLUTO
Neighborhood's Character			
ZIPDAMAGE	discrete	Number of the damaged buildings by the Sandy in the zip code area that the buidling is located in (buildings)	FEMA
ZIPINCOME	continuous	Median household income of the zip code area that the building is located in (dollar)	ACS2012
ZIPBLDGVALUE	continuous	Median property value of the zip code area tha the building is located in (dollar)	ACS2012
ZIPRENTVALUE	continuous	Median rent of the zip code area that the building is located in (dollar)	ACS2012
ZIPPCTRENT	continuous	Percentage of rent units to entire housing units of the zip code area (percent)	ACS2012
ZIPPCTVACANT	continuous	Vacancy rate of the zip code area that the building is located in (percent)	ACS2012

Table 1. Indepenent Variables for the Regression Model

Source: 1. FEMA: Modeling Task Force (MOTF) - Hurricane Sandy Impact Analysis, FEMA
2. PLUTO: Department of City Planning, New York City
3. ACS 2012: American Community Survey 2012 (5 years estimates), Census Bureau

zones may be ordered to evacuate. There are six zones, ranked by the risk of storm surge impact, with zone 1 being the most likely to flood. Therefore, the value of the ordinary variable, EVACU should be ranked by inverse order of the evacuation zone, i.e. the properties in zone one are ranked as 6, and those in zone six are ranked as one.

The simple regression analysis are conducted into entire three-boroughs level. The sample sizes of regression models of Brooklyn, Queens, Staten Island and entire boroughs are 202,860, 259,620, 112,815 and 575,294, respectively.

b. Spatial Regression Model: Geographically Weighted Regression Analysis

It is important to note that rates of changes are assumed to be universal; i.e. wherever a house is located the property values change associated with only the changes of the independent variables regardless their location. However, the model ignores the possibility that the correlations of housing value change and independent variables are varying depending on the location. Indeed, it might be more reasonable to assume that rates of change are also determined by location of the properties, rather than a global utility assumed for each commodity. For instance the distance from the Long Island Rail Road stations might be greater in Queens, where substantial number of residents commute by the train than Brooklyn where the stations are only three and the number of commuter using the rail road is relatively smaller than that of Queens.

The simple linear regression model can also make the significant error, when the model is non-stationary. According to the Simpson's paradox, when a model combines all of the groups together, and look at the data in aggregate form, the correlation that we noticed before may reverse itself. It argues that disaggregation allows the analysis to see patterns that we might not have seen otherwise. Since the correlation of the housing price change and the characters of both property and zip code area is non-stationary, the correlation should be analyzed based on the geographically weighted regression, or GWR, which is suitable to address non-stationary directly.

GWR allows the relationships to vary over space. In other words, the coefficients of independent variables do not need to be identical in everywhere. Since coefficients are calculated by their locations, GWR gives much better fits to data, by decreasing in degrees of freedom and residuals. To better capture the impacts of the Sandy damage and the other independent variables, this study introduces the GWR approach. The revised correlation between dependent variable and independent variables is as follows:

$$\begin{aligned} Y_{\Delta PROPVALUE} = \;& \beta_{i0} + \beta_{i1} X_{BLDGDAMAGE} + \beta_{i2} X_{EVACU} + \beta_{i3} X_{DISTMN} + \beta_{i4} X_{DISTSUB} + \beta_{i5} X_{DISTLIRR} \\ & + \beta_{i6} X_{DISTINTER} + \beta_{i7} X_{BLDGNEW} + \beta_{i8} X_{BLDGYEAR} + \beta_{i9} X_{BLDGAREA} + \beta_{i10} X_{BLDGVALUE} \\ & + \beta_{i11} X_{ZIPDAMAGE} + \beta_{i12} X_{ZIPINCOME} + \beta_{i13} X_{ZIPBLDGVALUE} + \beta_{i14} X_{ZIPRENTVALUE} \\ & + \beta_{i15} X_{ZIPPCTRENT} + \beta_{i16} X_{ZIPPCTVACANT} + e \end{aligned}$$

where β_{ik} is the value of the *k*th parameter at location (zip code area) *i*.

4. Analysis

Housing Market dynamics after hurricane Sandy

A variety of studies and researches have revealed that the housing markets in both New York

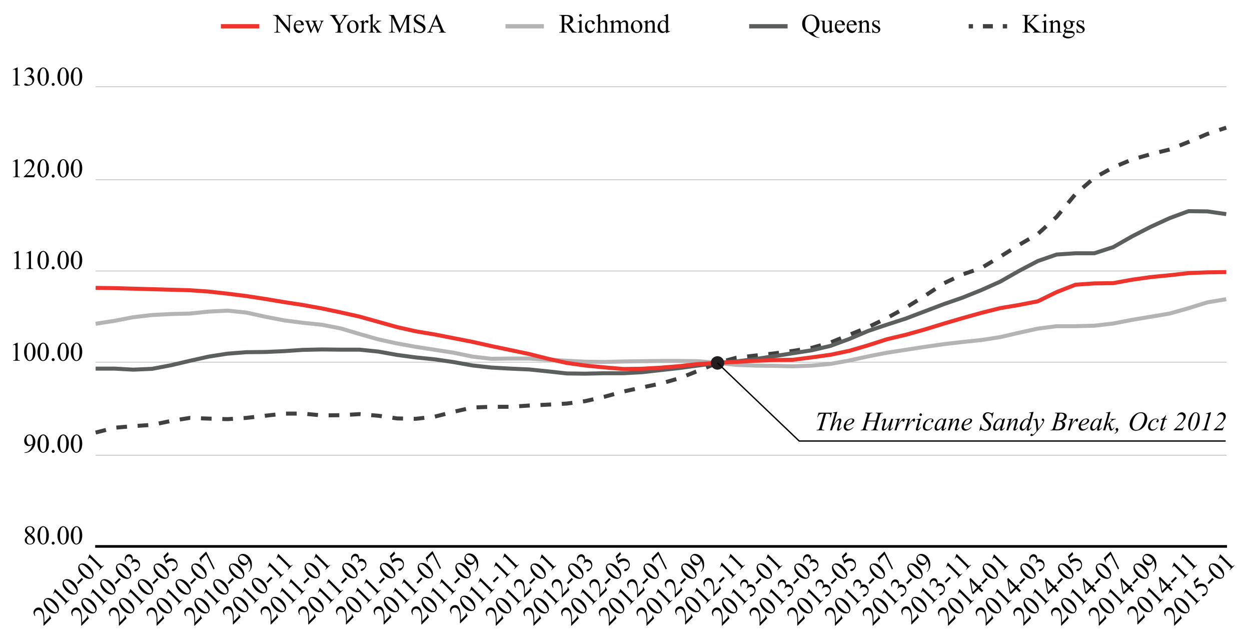

Figure 2. Median Housing Market Changes of New York MSA and Three Boroughs comparing with the value on October 2012
Source: zillow.com

Metropolitan Statistical Area and the three boroughs have been inflated, after hurricane Sandy. Figure 2 shows the diachronic median property value comparison of New York MSA and three boroughs based on Zestimate monthly data. The graph sets the median property values of those markets at October 2012, when the Sandy hit New York City, as base values and recalculated the property values from 2010 to not, based on the base values.

The graph indicates that the housing market of New York MSA rebound before and after the Sandy. Before the Sandy, housing markets in New York City underwent long-term deflation/stagnation due to the Subprime mortgage crisis and the European sovereign debt crisis. However, after the Sandy, housing market turned to inflation and housing value of both metropolitan area and three boroughs stated increasing. By January 2015, the median property value of New York MSA, Brooklyn, Queens and Staten Island boroughs increase 9.90 percent, 25.64 percent, 16.22 percent and 6.95 percent, respectively.

However, the degrees of the increases are varying not only by borough and but also by location of individual properties. Figure 3, 4, 5 and 6 show the interpolated property value changes in the three boroughs. The figures break the area into four groups based on the quartile of percentage of housing price changes within two years after the Sandy. The first quartile group is the area where the housing market values decrease or increase less than 9.15 percent. The thresholds of second and third quartile are 12.72 percent and 14.90 percent, respectively. Lastly, the fourth quartile group is the area where the property values increase more than 14.90 percent. Schematically, Figure 3 shows that there is a difference of increase of property by Borough. In Brooklyn, approximately

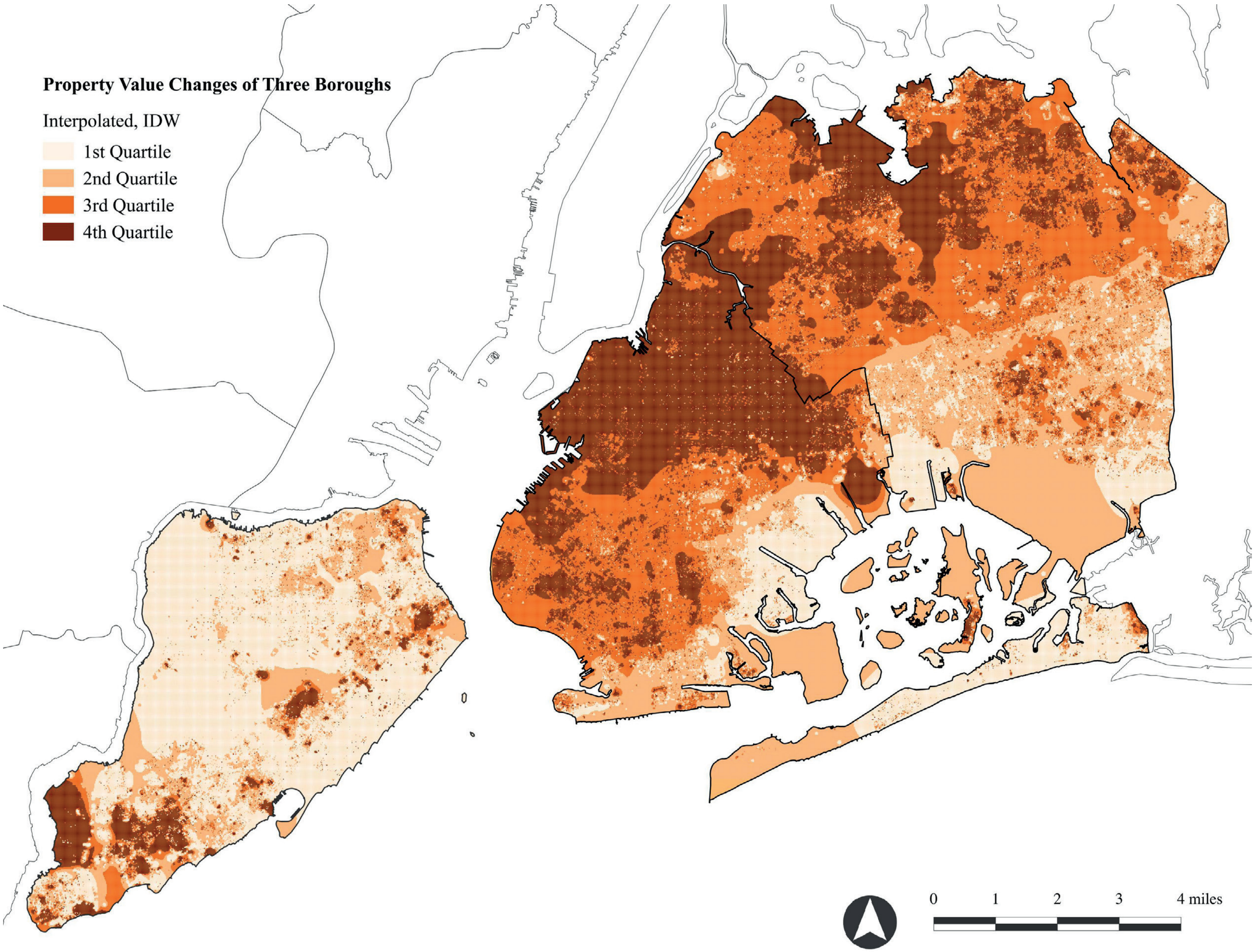

Figure 3. Interpolated Property Value Changes, Three Boroughs
Source: Property Assessment Roll FY2012 and 2016, Department of Finance, New York City

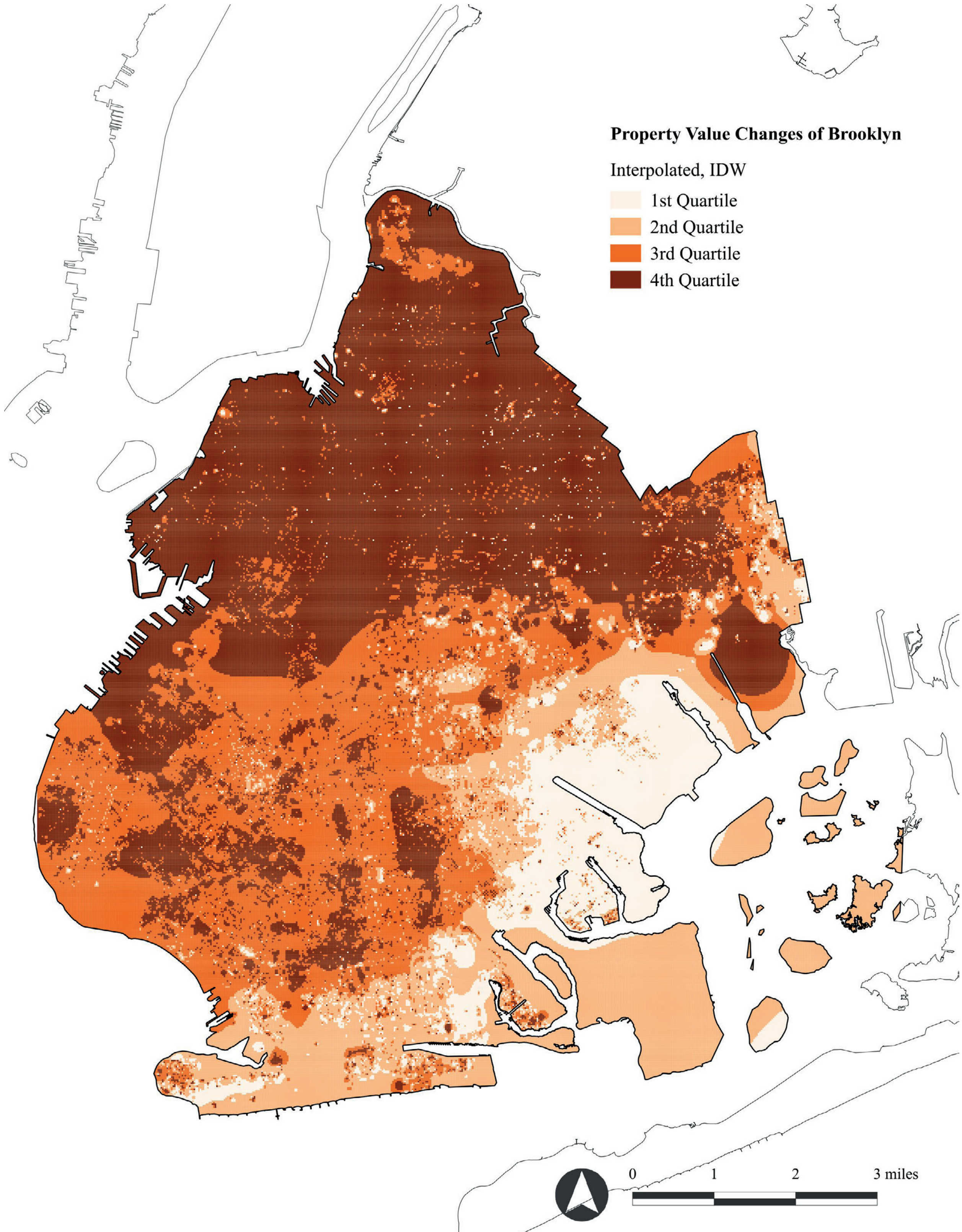

Figure 4. Interpolated Property Value Changes, Brooklyn
Source: Property Assessment Roll FY2012 and 2016, Department of Finance, New York City

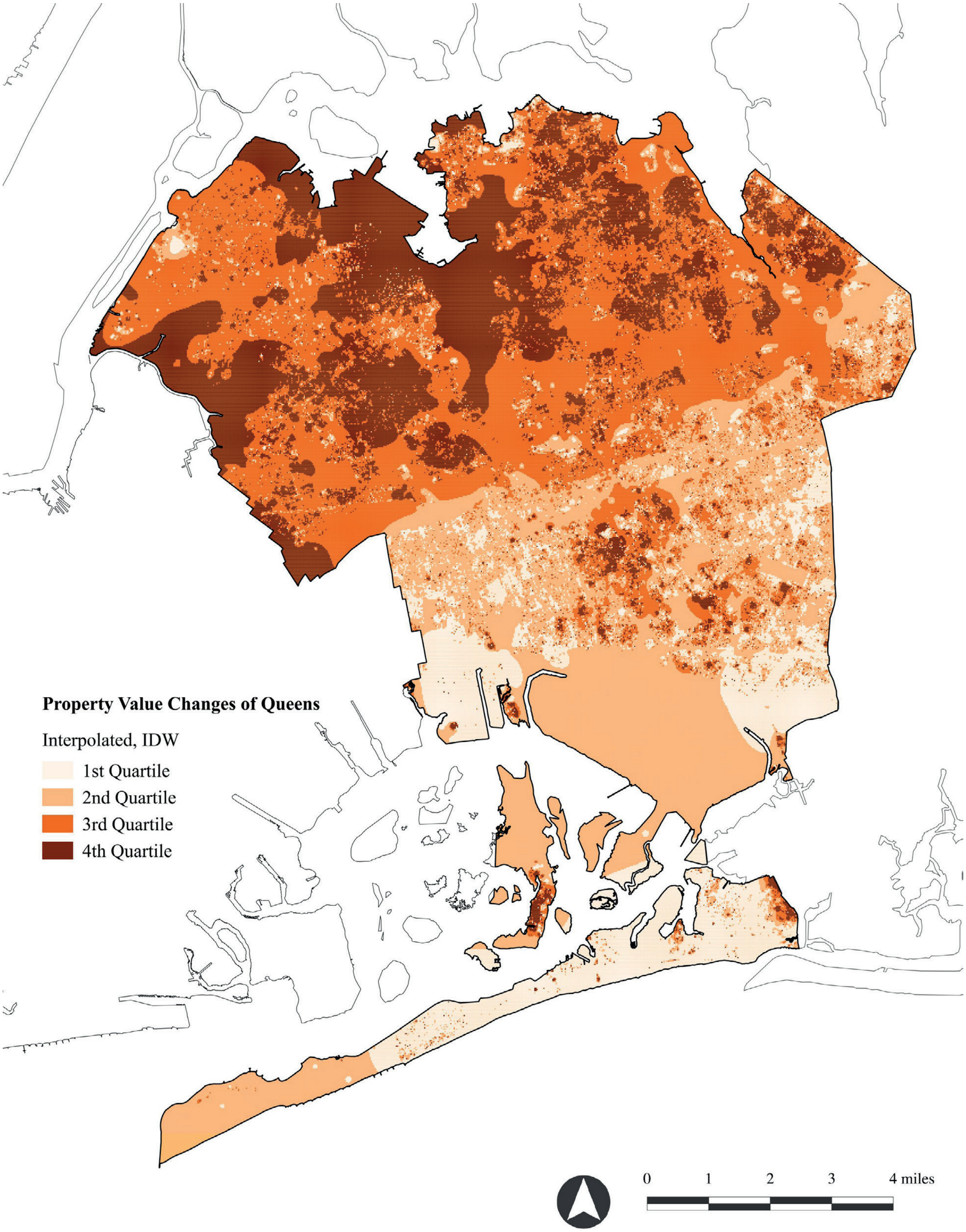

Figure 5. Interpolated Property Value Changes, Queens
Source: Property Assessment Roll FY2012 and 2016, Department of Finance, New York City

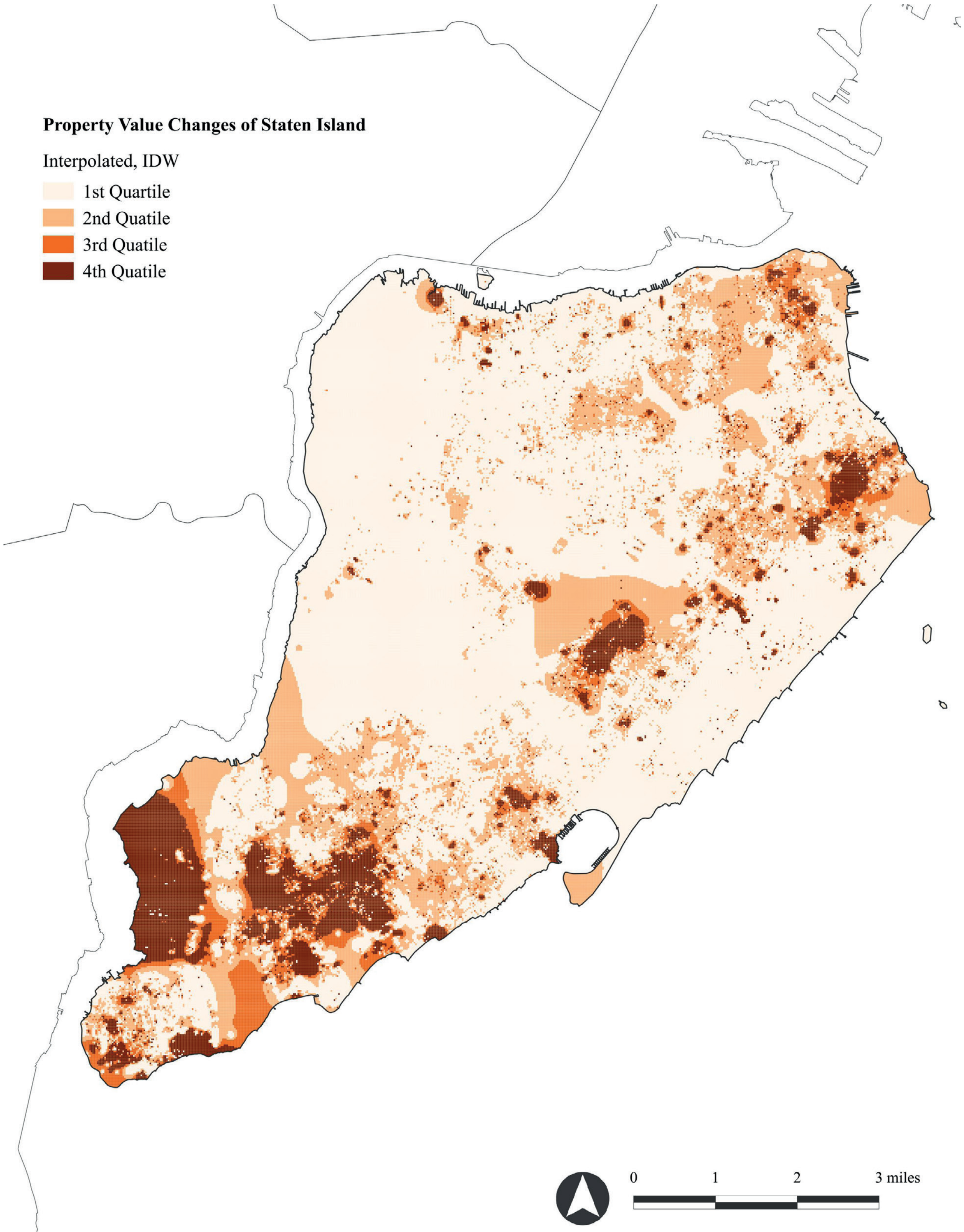

Figure 6. Interpolated Property Value Changes, Staten Island
Source: Property Assessment Roll FY2012 and 2016, Department of Finance, New York City

more than 30 percent of the borough areas are classified as fourth quartile. On the contrary, in Staten Island, the share of areas of fourth quartile is very rare and concentrated mostly in Southern Staten Island.

In Brooklyn, housing value changes gradually increase as the distance to Manhattan decrease. According to Figure 4, there are several clusters of housing inflation area (fourth quartile) in mid-North Brooklyn and some others in the South are formed only near the subway stations. Unlike previous literature's idea, which argues that the disaster event gentrified the affected area, in most affected area of Southern Brooklyn, such as Coney Island and Barren Island, housing price changes are relatively smaller than other area. Therefore, in Brooklyn's case, property values seem to be substantially sensitive to proximity to Manhattan rather than influence of the Sandy seems very weak.

Roughly, the tendency of property value changes in Queens is similar to that in Brooklyn; housing price change is in inverse proportion to the proximity to Manhattan. However, the distribution of inflated area of Queens presents a contrast to Brooklyn's case. Firstly, the share of fourth quartile area in Queens is much lesser than that in Brooklyn; less than 10 percent of entire area is fourth quartile area. Secondly, whereas the clusters of fourth quartile areas are sporadically dispersed, third quartile areas cover in upper half of the borough and near Jamaica. Thirdly, these clusters of inflated housing market area are formed near subway and Long Island Rail Road stations as centers. Clusters centering Long Island Rail Roads and subway stations shows that the property values in Queens are significantly related with the accessibility to public transit. Interestingly, Flushing Meadows, one of most surged areas during the Sandy, is experiencing the inflation of housing market. Therefore, it is difficult to conclude that the impact of the Sandy is weak as well as Brooklyn's case.

The housing market change in Staten Island is distinct comparing with the changes of above two boroughs. First above all, most of entire areas in Staten Island are under the category of first quartile; clusters of fourth quartile are formed in the southern borough and somewhat in middle and upper east of the borough, but the proportion of the fourth quartile is very small. Secondly, contradicting from above two boroughs, the largest cluster of inflated market area is formed near New Jersey. This indicates that although Staten Island is a borough of New York City, the economy of New Jersey is more influential than that of Manhattan due to its physical distance and accessibility. In brief, the housing market change of Staten Island is fully relying on the proximity of New Jersey and Staten Island Railway, which across the borough north east to south west. However, there is low correlation between the housing market change and impact of the Sandy.

In sum, both natural and socio-economic factors' degrees of impacts on the housing markets are varying by boroughs. The proximity to Manhattan is influential factor increasing housing

Variable	Type	Unit	Mean	Std. Error	Min	Max	Coefficient
Property Value Change, Dependent Variable							
Dvalue	C	USD	2430.4350	9,096.4080	-3,642,731	656,994	-
Hurricane Sandy Damage/Risk							
BLDGDAMAGE	B	-	.0501	.2182	0	1	-416.6487***
EVACU	O	-	1.4832	1.6562	0	6	-443.6090***
Accessibility to Manhattan							
DISTMN	C	miles	8.0690	3.3671	.7378	18.6180	30.5575***
DISTSUB	C	miles	2.8674	2.4742	.0092	9.4088	151.7391***
DISTHIGH	C	miles	.9175	.6368	.0142	4.3106	-144.1178***
Building's Character							
BLDGNEW	B	-	.0027	.0518	0	1	-786.7776***
BLDGYEAR	D	year	1944.5770	31.0636	1729	2015	2.9831***
BLDGAREA	C	s.f.	2,578.1380	11,125.8100	120	2690565	.0096***
BLDGVALUE	C	USD	23,968.8200	37,968.2300	1	1.64E+07	-.2000***
Neighborhood's Character							
ZIPDAMAGE	D	units	36.7823	83.5165	0	561	2.2157***
ZIPINCOME	C	USD	59,934.27	16,120.02	24,640.00		-.0393***
ZIPBLDGVALUE	C	USD	503,634.20	102,032.50	257,400.00	898,400.00	.0070***
ZIPRENTVALUE	C	USD	1,226.48	164.26	726.00	1,894.00	5.7928***
ZIPPCTRENT	C	percent	49.6629	20.2094	4.8220	98.0125	11.3069***
ZIPPCTVACANT	C	percent	.0747	.0267	.0136	.3593	-254.3591***
Constant	-	-	-	-	-	-	-5,500.3200***

Table 2. Statistics Summary and Correlations for Property Value Changes across Three Boroughs
Type: B = Binary, C = Continuous, D = Discrete, O = Ordinal
Level of Significance of Coefficients * = p-value <.1, ** = p-value<.05, *** = p-value<.01
Sample Size = 575,294
R-Square = .7109

value in Brooklyn and Queens, whereas the proximity to New Jersey is much more important to determine the property value in Staten Island. According to analysis of value change maps, it seems less likely for hurricane Sandy to impact on the housing market change in Brooklyn and Staten Island. However, it is hasty to conclude that there is not any correlation between the Sandy and housing market change in the affected areas.

Correlation between Hurricane Sandy and Housing Market Dynamics in Three Boroughs

a. Simple Regression Analysis

For grasping rough sense of correleation between the Sandy and housing market dynamics, the study conducted simple linear regression analsys with 575,294 samples in three boroughs. Table 2 provides statistical summaries and coefficients of independent variables, as a result of the simple regression model. Due to the sample size, whole variables are statistically significant, which means level of significance of each variable is above .99. Clearly these indicators yield no single dominant influence on the housing market change.

Both damage from the Sandy and risk of evacuation by hurricanes and floods have a negative relationship with property value changes. Affected properties are assessed $403.61 lesser than non-affected properties, even if other conditions of both properties, including both building and neighborhood characters, are identical. Likewise, the value of the property located in non-evacuation zone increase approximately $2,650 more than the property located in evacuation zone 1. Based on the regression analsys of two independent variables, *BLDGDAMAGE* and *EVACU*, it is plausible to argue that the Sandy decreased the property values in affected area.

On the contrary, the coefficient of the variable *ZIPDAMAGE*, which indicates the level of damage in surrounding neighborhood, conflicts the idea that the disaster events have negative impact on housing markets, above. The coefficient of the variable is positive and it means that the more number of buildings damaged in a certain area, the higher inflation of property values in the area. For example, the property in zip code area, 11,697, at the end of Rockaway Peninsula is assessed approximately $1,230 more than the property in zip code area, 11,001, the inland area in Queens. In this case, the impact of hurricane Sandy has increased property value, and this is probably due to the imbalance of supply and demand of housing units, as previous literature argues.

The simple linear regression model provide general perspective of the relationship between housing market dynamics and varying factors including both natural and socio-economic attributes that the three boroughs area have. However, the model fails to clarify the correlation between the Sandy and housing market change by examining contradict results of coefficients of three independent variables of damage/risk of Sandy. The correlations across the three boroughs should not be explained by one simple regression model; the relationship between the Sandy and housing market changes is non-stationary, which means impacts of the Sandy on local housing markets are diverse depending on their location. Therefore, more elaborate analysis approach is necessary.

b. Geographically Weighted Regression Analysis

In order to complement the statistical limitation of the simple linear regression model, the study conducted Geographically Weighted Regression Analysis. The R-Squared value improves from .7109 (in simple linear regression analysis) to .9117 (in GWR analysis), which reflects the improvement of fit to data. Moreover, unlike simple linear regression model, which examine only one static/stationary coefficient of each independent variable, the GWR analysis reveals that coefficients of independent variables are varying in regard to both magnitude and direction of the

Variable	Mean	Std. Error	Min	Mass
Hurricane Sandy Damage/Risk				
BLDGDAMAGE	-2,514.4800	3,838.1390	.0501	.2182
EVACU	-613.6181	352.7172	1.4832	1.6562
Accessibility to Manhattan				
DISTMN	-95.3053	330.0167	-994.6064	817.8007
DISTSUB	254.3212	319.2097	-297.2717	1,333.9250
DISTHIGH	-157.7068	355.4548	-788.2603	1,056.321
Building's Character				
BLDGNEW	9.0899E+4	3.4447E+5	-1.4697E+6	5.2195E+5
BLDGYEAR	8.7546	30.4328	-41.3061	140.9279
BLDGAREA	-.0198	1.1214	-6.2828	2.3521
BLDGVALUE2012	-.0975	.1560	-.2216	.2191
Neighborhood's Character				
ZIPDAMAGE	6.8686	10.5299	-13.4115	43.6234
ZIPINCOME	.05600	.0616	-.0704	.2382
ZIPBLDGVALUE	.0028	.0079	-.0090	.0331
ZIPRENTVALUE	1.1001	4.6097	-15.8817	11.9233
ZIPPCTRENT	-7,087.3830	9,076.0680	-25,224.3600	11,466.7700
ZIPPCTVACANT	2,961.4520	5,398.3910	-3,437.4810	29,269.8200
Local R-Square	.9117	.1298	.4685	1.000

Table 3. Summary of Correelations for Property Value Changes across Three Boroughs by Zipcode Area

coefficients; even a specific independent can have a positive influence on an area, but at the same time, it has a negative impact on another area (See Table 3). Among the sixteen of independent variables, the study focuses on three variables, which are related with the damage or risk of hurricanes and floods: *EVACU*, *BLDGDAMAGE*, and *ZIPDAMAGE* [11].

Figure 7 shows how the risk of the evacuation during floods changes the property values in three-borough area after the Sandy. Across the whole extent of the boroughs, the risk of evacuation has a negative impact on the property value. Especially, the negative impact is severe in the most damaged area, such as southern Staten Island, Coney Island and Far Rockaway Island. The inverse correlation between the risk of disaster and property value supports the idea of previous literature, which argue that buyers' and sellers' risk perceptions of floods makes the transaction prices lower.

However, unlike the impact of risk of floods and hurricane (*EVACU*), the impacts of actual damages of the Sandy on individual property values (*BLDGDAMAGE*) are varying on the location in terms of both magnitude and direction. Figure 8 shows the correlation between the damages on

11. The rest results are given in Appendix A.

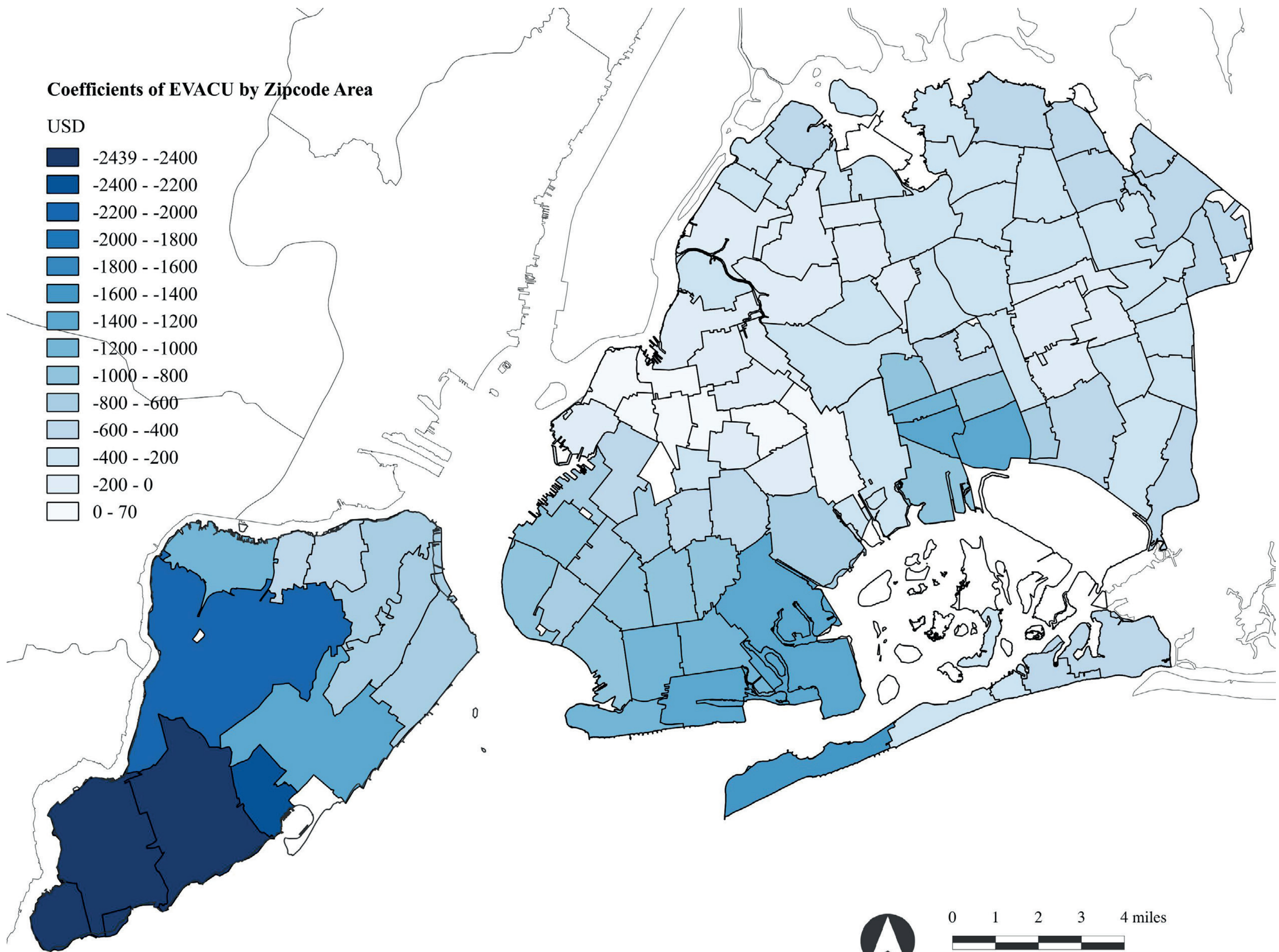

Figure 7. Distribution of Coefficient of *EVACU* by Zipcode Area

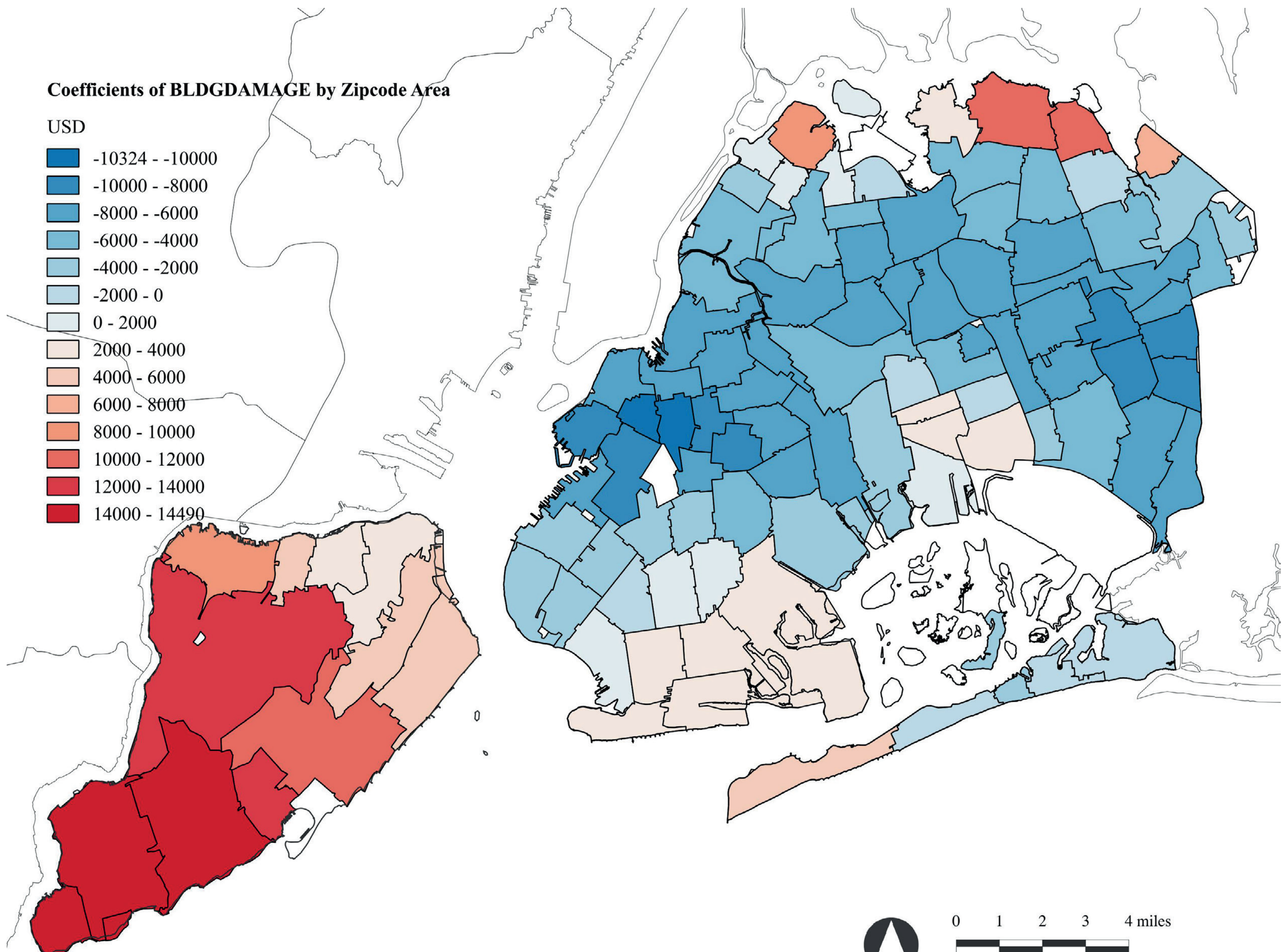

Figure 8. Distribution of Coefficient of *BLDGDAMAGE* by Zipcode Area

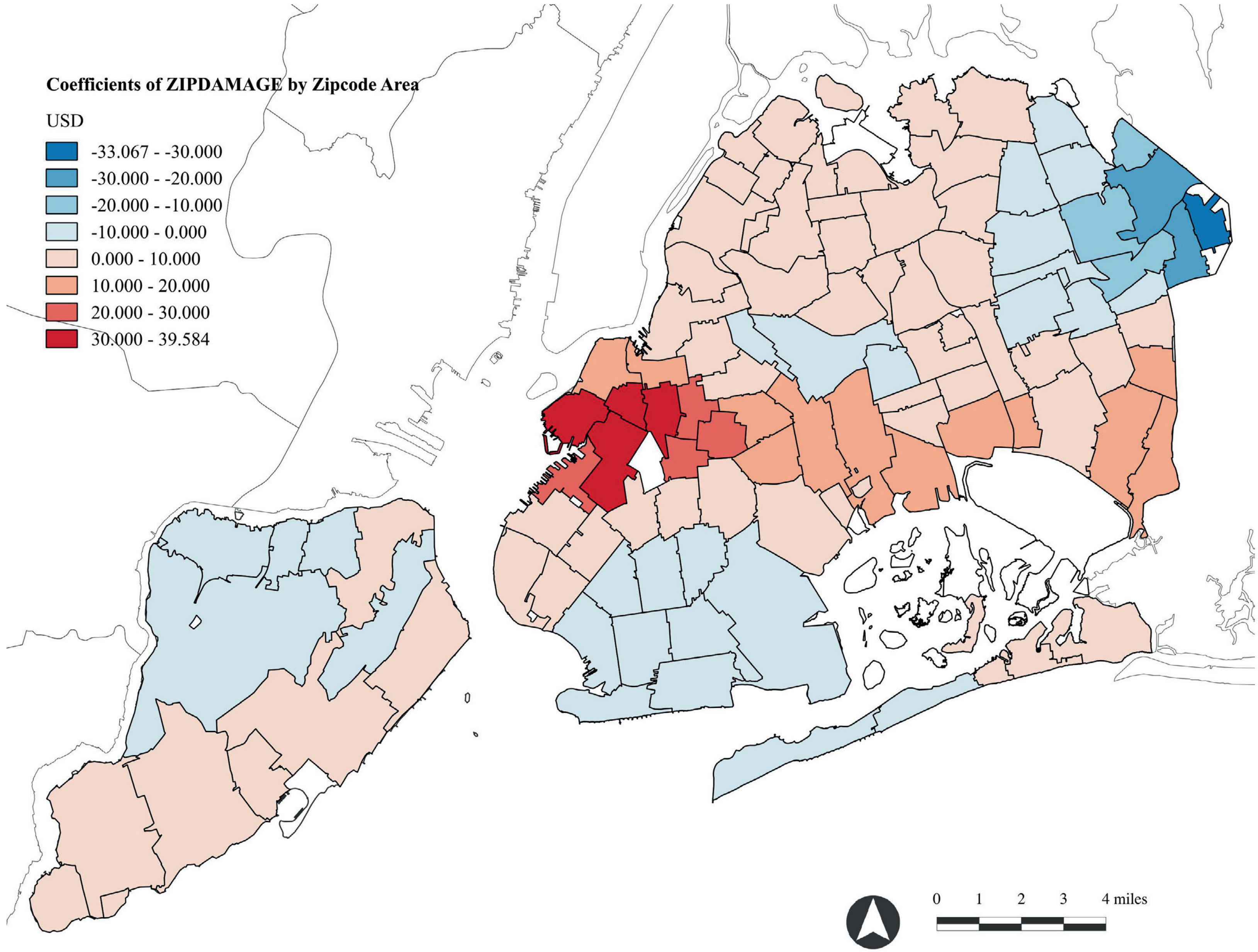

Figure 9. Distribution of Coefficient of *ZIPDAMAGE* by Zipcode Area

individual properties and their assessed values. The GWR analysis indicates that there are several tendencies of the coefficient by the location. In a broad perspective, the fact, whether the property was affected or not by the Sandy, has a negative impact on its value in most area in Brooklyn and Queens. This is because if the Sandy hit a building both directly and indirectly, the building would deteriorate and be diverted under undesirable conditions. Therefore, the value of the damaged property would underestimate in housing market.

However, the impact of damaged building to property value is absolutely changed in severely damaged area such as Staten Island, Coney Island, Rockaway and so forth. In these areas, the impact of the Sandy increases the property value due to the improvement of physical environment of the neighborhoods. To be specific, because numbers of properties in the area were destroyed or damaged by the Sandy, property owners of destroyed/damaged buildings tried to reconstruct their not only damaged but also deteriorated buildings better than pre-Sandy conditions. Morever, the City has injected tons of public funds not only for recovery of the neighborhood but also for building better neighborhoods. As a result, efforts in both public and private realms would make the affected neighborhood environment more desirable to live than even before the Sandy. For these reasons, even though the buildings that were damaged by the Sandy are more likely underestimated than not-damaged property even if other conditions are identical, the damage from the Sandy has a positive impact on housing market in terms of property value in the areas that were damaged by the Sandy severely.

The housing market changes of the neighborhood nearby damaged buildings are different from by those on the property itself [12]. Figure 9 examines the coefficient of the variable of *ZIPDAMAGE*, which indicates the number of damaged building in zipcode area where a property is located. According to the result of the GWR analysis on coefficients of *ZIPDAMAGE* by zip code area, there is a positive correlation between the variable and housing market change in the places where the accessibility to Manhattan and New Jersey is better than others. Especially, the coefficient is extremely high in neighborhoods in Northwestern Brooklyn, such as DUMBO, Red Hook and so forth, which are known as already gentrified areas before Sandy occured.

In recent decades, property owners in the places where the accessiblity to Manhattan is easy have eagerly wanted to upgrade their properties to be more profitable. However, due to several regulations of redevelopment, they have been discouraged gentrifying their properties. In this situation, hurricane can be a chance to gentrify their property due to the massive destruction

12. The independent variables of *BLDGDAMAGE* and *ZIPDAMAGE* indicate different aspects of damage from Sandy. Even though a property was not damaged/destroyed by Sandy, the damage to the property can be considered substantial in terms of the independent variable, *ZIPDAMAGE*, when there are large number of damaged building nearby the property. On the contrary, in terms of *BLDGDAMAGE,* a property can be considered damaged regardless its surroudings, if the property was damaged by Sandy.

of deteriorated of their properties. Property owners are able to reconstruct their property with the compensations from both public and private realms. Since they replace the existing damaged building with new and upgraded larger building, the property owners can get benefit from the destruction.

Massive evacuation of renters also stimulates the gentrification of affected area. Due to the renters' protection[13], property owners have had difficulty to upgrade their property even if their properties are located in good place in terms of accessibility to Manhattan and they have sufficient capital to reconstruct their properties. However, as senate of Thailand mentioned after the tsunami, the natural disaster has done the job that the developers have tried before to chase people away for them. Thanks to the Sandy, many property owners could upgrade their property without worrying about evicting their tenants, and consequently, the their property assets increase drastically. These situations also happened in the Northwestern Brooklyn region extremely and the spatial regression analysis examines the phenomena.

5. Conclusion

By using Geographically Weighted Regression model, the study shows how Sandy has had impact on housing market changes in New York City differentially across small-scale geographies. On the contrary to previous literatures, the impact of hurricane Sandy on housing market cannot be explained with one simple regression model. The impacts of Sandy on property values in the affected areas are varying on their locational characteristics; even if the Sandy affected two different areas identically, the impact of the Sandy on housing market of both areas could be different based on their location.

Rather the Sandy has impacted on the local housing market unto itself, the impact was combined with other characteristics that the affected area already have had. Especially, the proximity and accessiblity to urban core, i.e. Manhattan in Brooklyn and Queens Boroughs' case and Jersey City in Staten Island Borough's case, are crucial factors that determine the direction of Sandy's impact on the local housing markets. In spite of utmost support from public realms, the affected neighborhoods, which are remote from downtown, have undergone the housing market reccession due to the destruction and deterioration of properties and risk of future disaster. On the contrary, neighborhoods, where the access to downtowns is easier than other neighborhoods, have

13. In New York City, a tenant with a lease is protected from eviction during the lease period so long as the tenant does not violate any substantial provision of the lease or any local housing laws or codes. For both regulated and unregulated apartments, landlords must give formal notice of their intention to obtain legal possession of the apartment (Schneiderman, 2011)

experienced the steady inflation of their housing market because the their future value from the gentrification exceeded the current damage from Sandy.

Both inflation and recession of the housing market after Sandy are crucial to residents in New York City, especially to low and mid income households. Housing market inflation decreases the renters' affordability. This is because the hurricane allowed property owners to rebuild their property upgraded and larger and therefore, the absolute amount of small size of affordable housing units decrease. Since the demand of affordable housing is not change, whereas the supply decrease, the rent price increase drastically. Consequently, due to the increase of rents, they have to pay more proportion of their income to housing cost.

On the contrary, housing market recession can have disparate negative impacts on lower-income and minority occupied neighborhoods. The stagnation of housing market will cause in part by the collapse of the housing finance system and by continued job losses. The recession can also depress household formation due to the reduction in economic activity, increases in unemployment rates and declines in income and wealth (Painter, 2010). One thing that the recession of housing market has in common with inflation of the market is that it also makes life more difficult for economically vulnerable households.

The problem of both New York City and the Federal governments recovery plans have neglected the differences of impacts on housing market in New York City and have fully concentrated on the physical recovery of damaged housing units. Former Bloomberg Administration's 'Build it Back' program (BIB program) shows the drawback of conventional municipalities' post-disaster recovery plans. Without confronting fundamental housing problems that the City has had before the Sandy, the administration was immersed only in restoring damaged properties with physical reconstruction. Unfortunately, the BIB program failed to address the fundamental housing problems of New York City, such as the lack of housing affordability, extremely high household budgets devoting to housing costs and so forth, and fluctuating housing market changes of local markets after Sandy, which this study already examines in chapter 4, verify the failure.

Without elaborately designed neighborhood-wide recovery plans, the New York City will fail to handle a variety of housing issues that local neighborhoods have had after the Sandy. Even though the affected neighborhoods have experienced housing crises, causes and solutions of these crises are absolutely different by neighborhoods' situations. Therefore, the City should take different approaches to deal with the housing market problem whether the housing market has experienced inflation or reccession.

Fortunately, current de Blasio administration is showing different move from former mayor's approach. According to Mayor's 'Housing New York, A Five-Borough, Ten Year Plan', the City is "pursuing affordable housing and community development opportunities in all five boroughs" by working with communities to identify the problems that the communities confront and opportunity that they have had (Mayor Bill de Blasio, 2014). In this situation, the study anticipate that this research can examine meaningful insight providing the City's policy makers with the clue to device a reasonable and efficient housing recovery plan.

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Appendix A. Results of Geographically Weighted Regression Analysis - 1) DISTMN

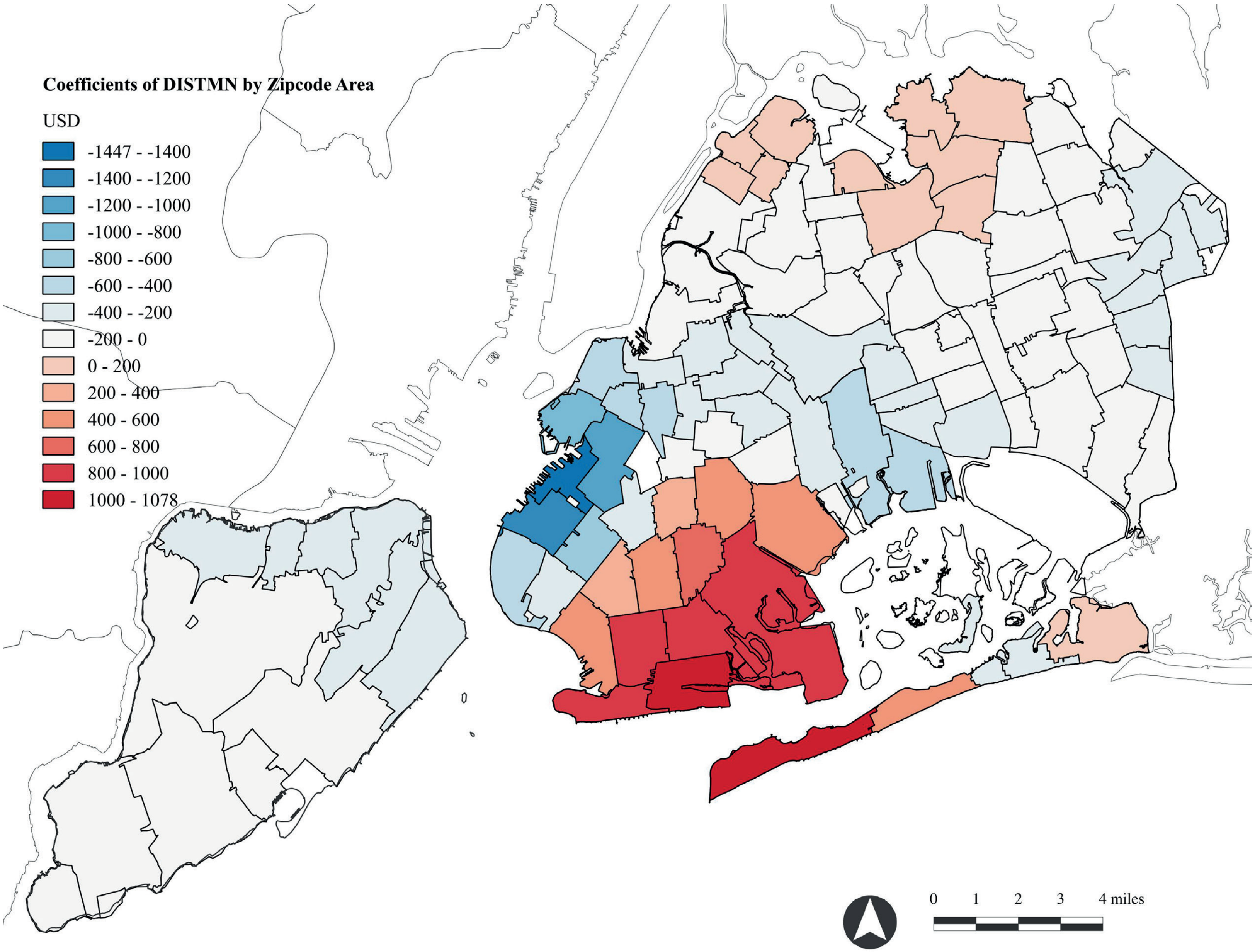

Figure A-1. Distribution of Coefficient of *DISTMN* by Zipcode Area

2) DISTSUB

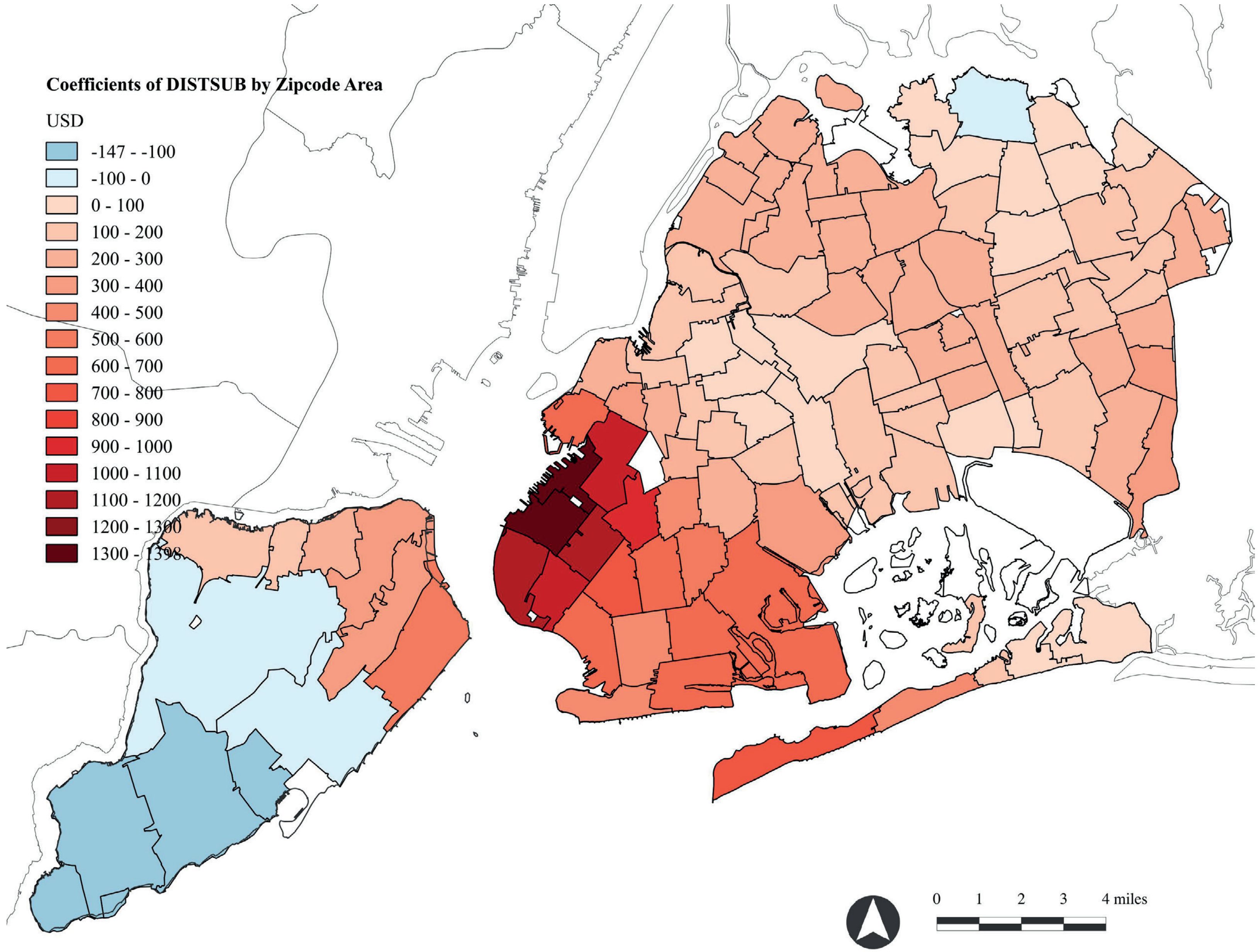

Figure A-2. Distribution of Coefficient of *DISTSUB* by Zipcode Area

3) DISTHIGH

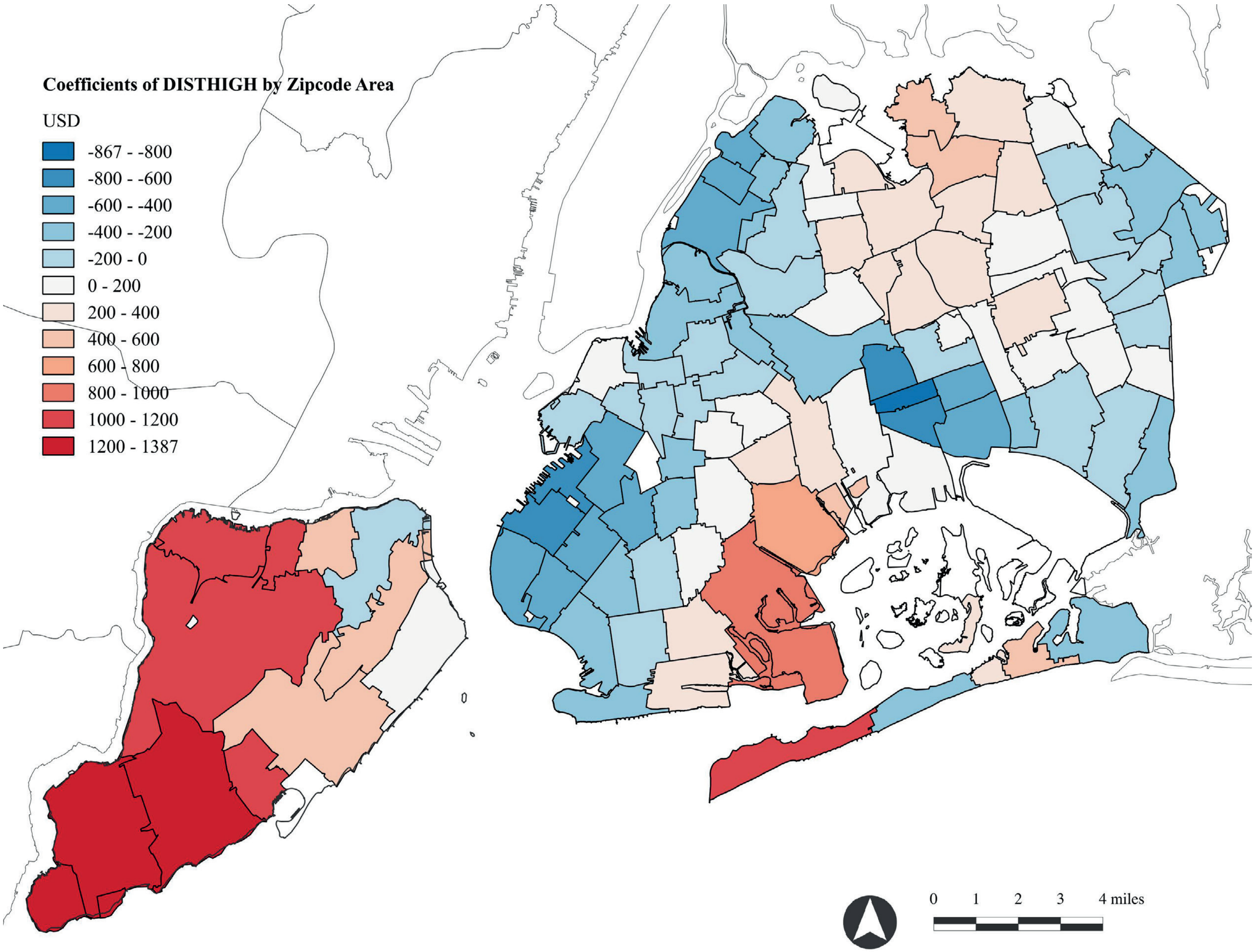

Figure A-3. Distribution of Coefficient of *DISTHIGH* by Zipcode Area

4) BLDGNEW

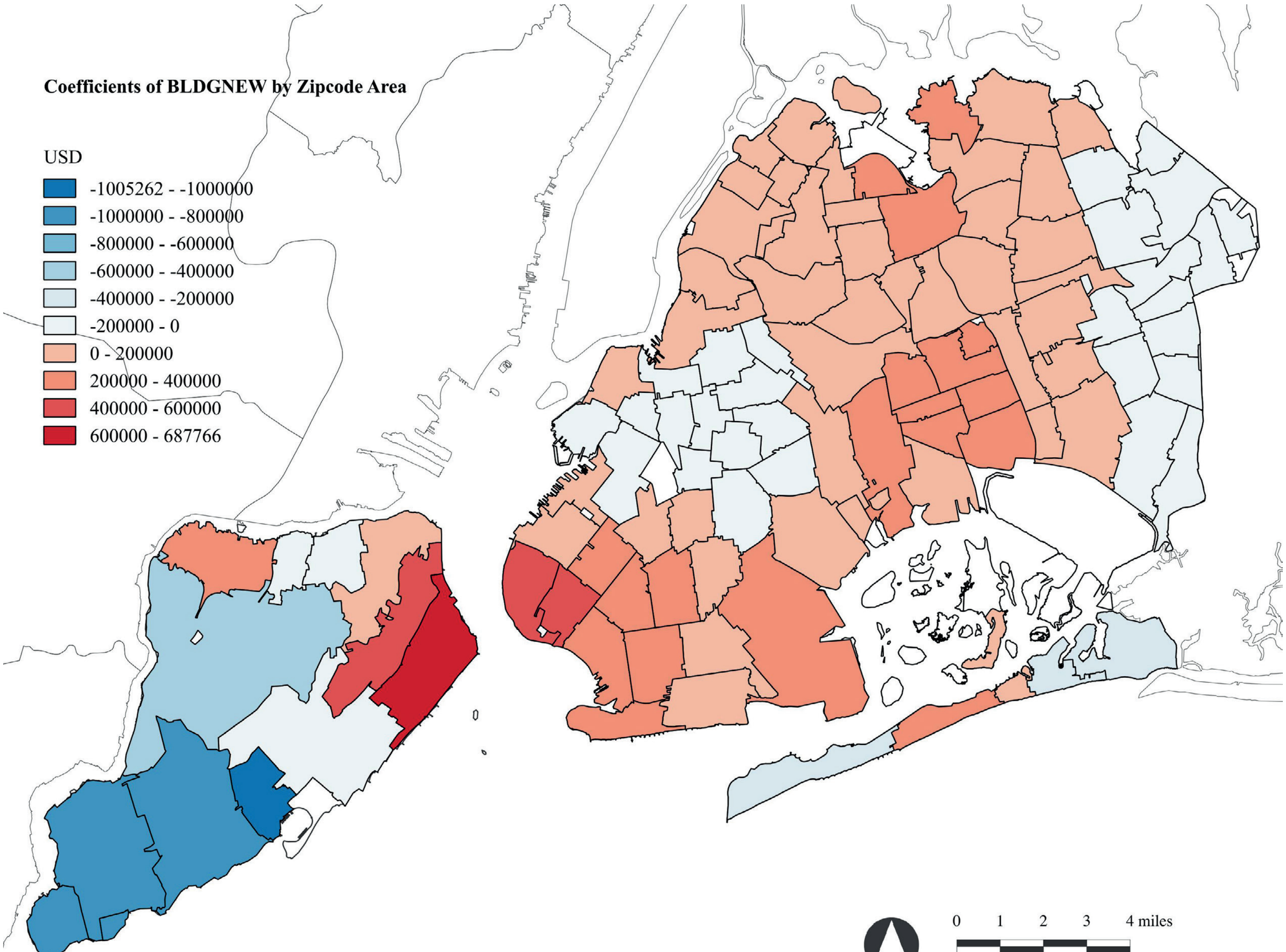

Figure A-4. Distribution of Coefficient of *BLDGNEW* by Zipcode Area

5) BLDGYEAR

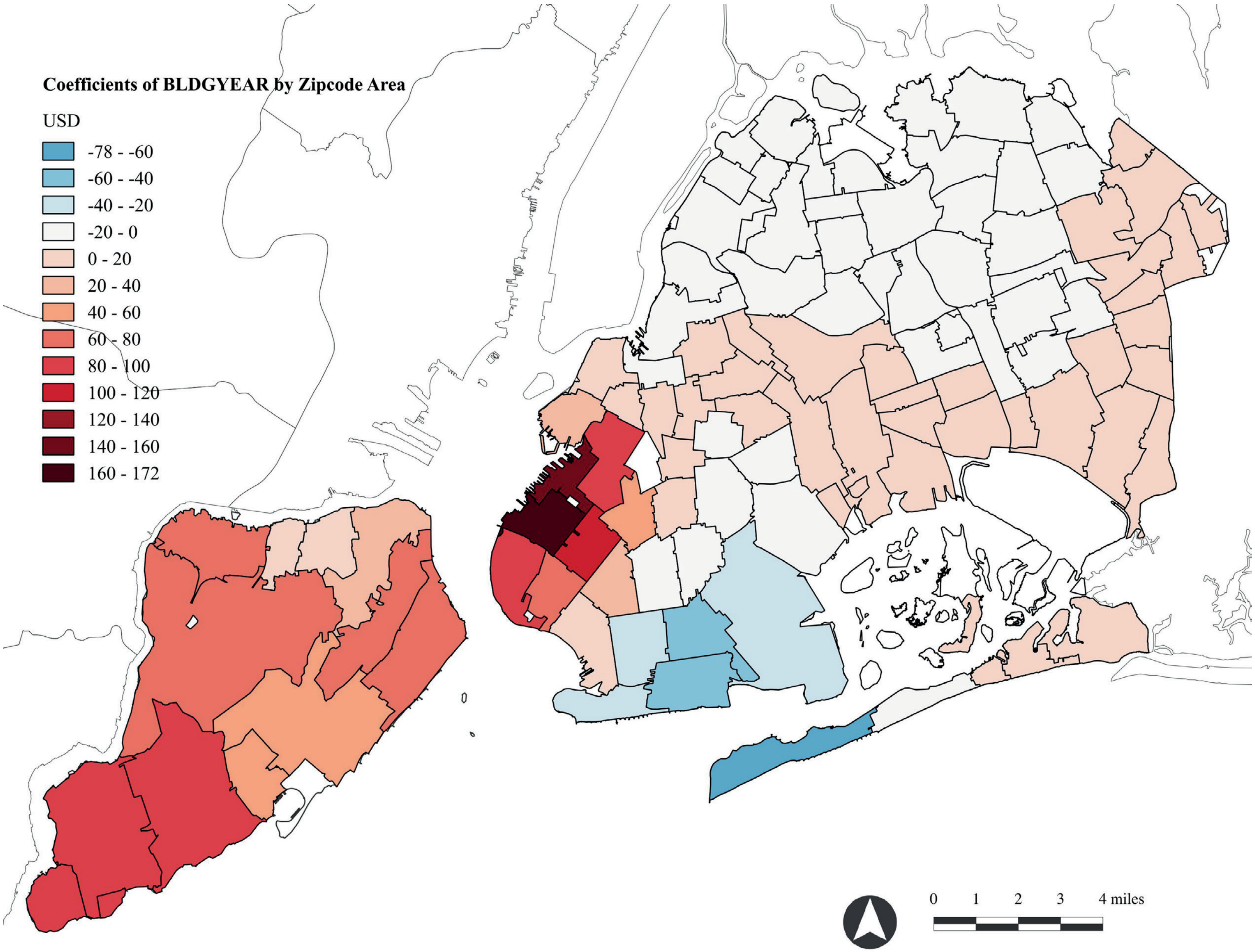

Figure A-5. Distribution of Coefficient of *BLDGYEAR* by Zipcode Area

6) BLDGAREA

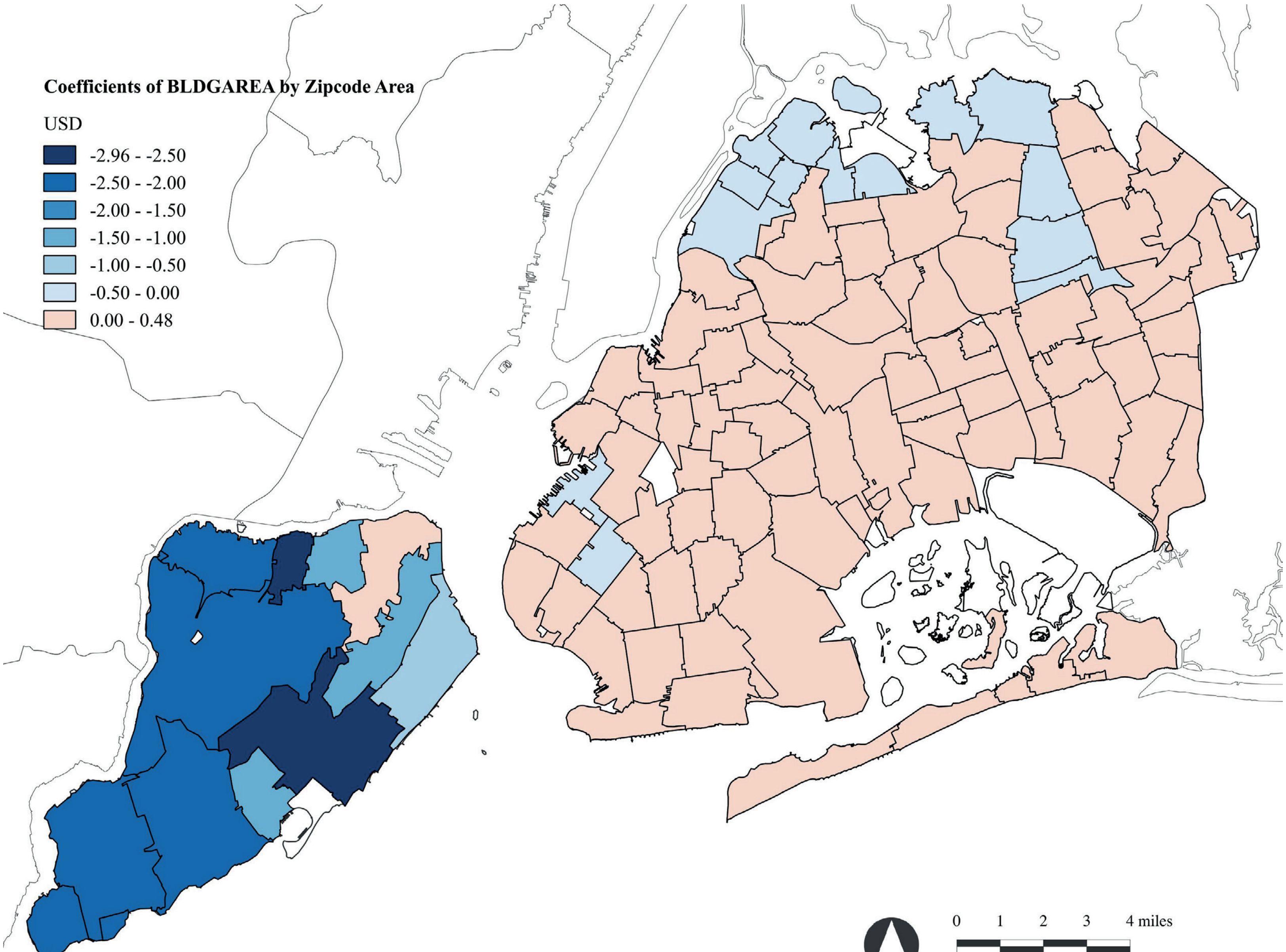

Figure A-6. Distribution of Coefficient of *BLDGAREA* by Zipcode Area

7) BLDGVALUE

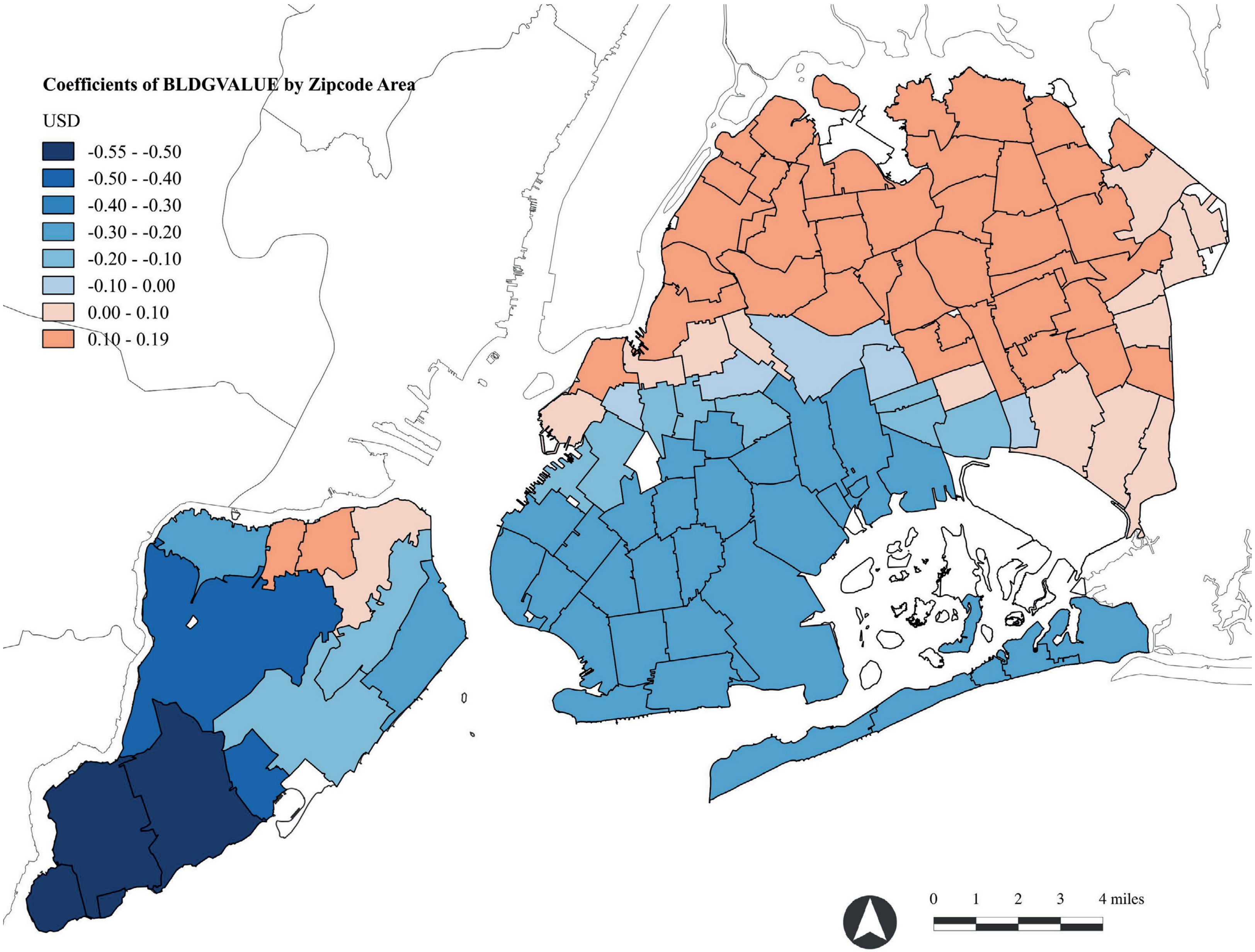

Figure A-7. Distribution of Coefficient of *BLDGVALUE* by Zipcode Area

8) ZIPINCOME

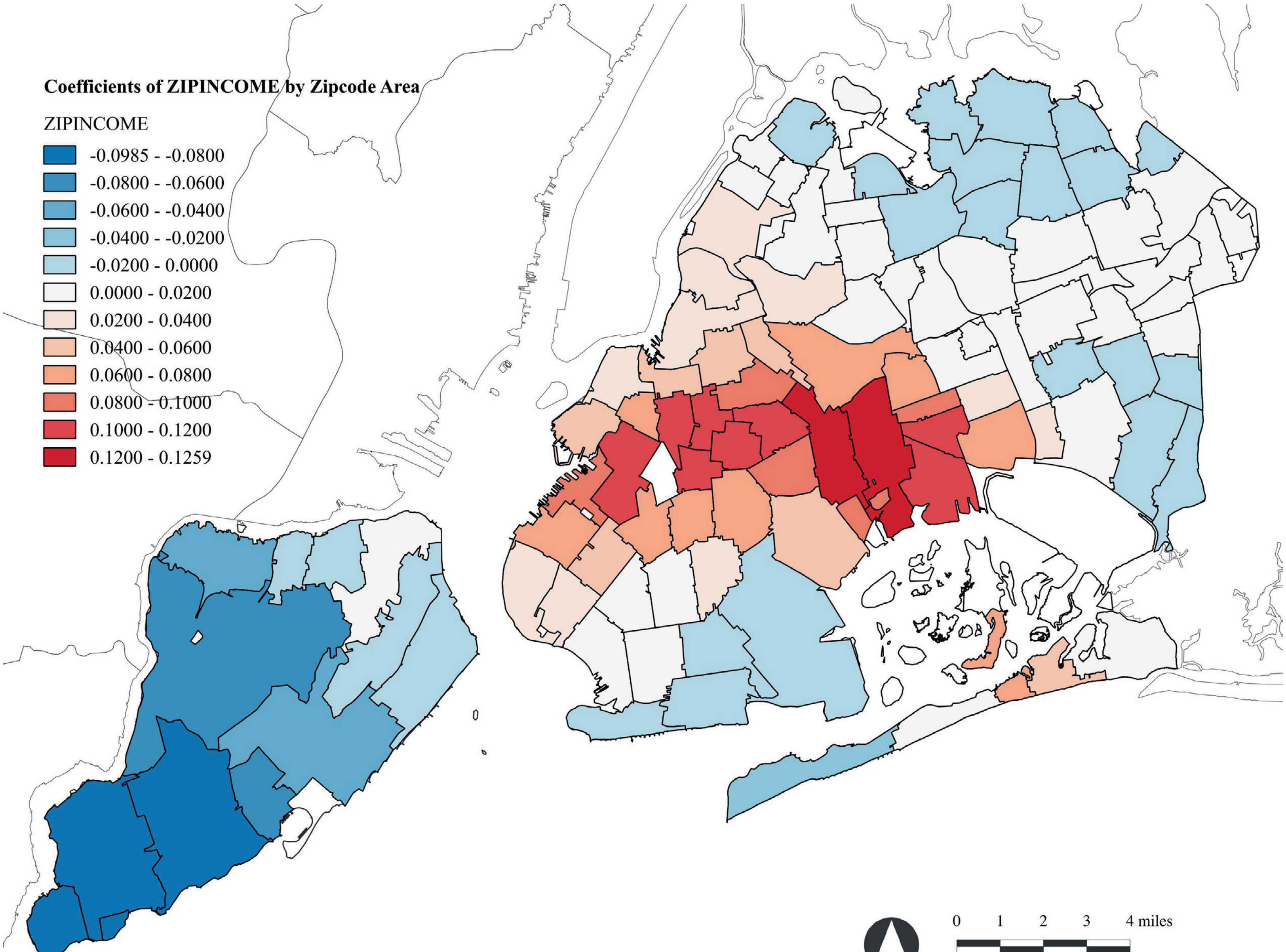

Figure A-8. Distribution of Coefficient of *ZIPINCOME* by Zipcode Area

9) ZIPBLDGVALUE

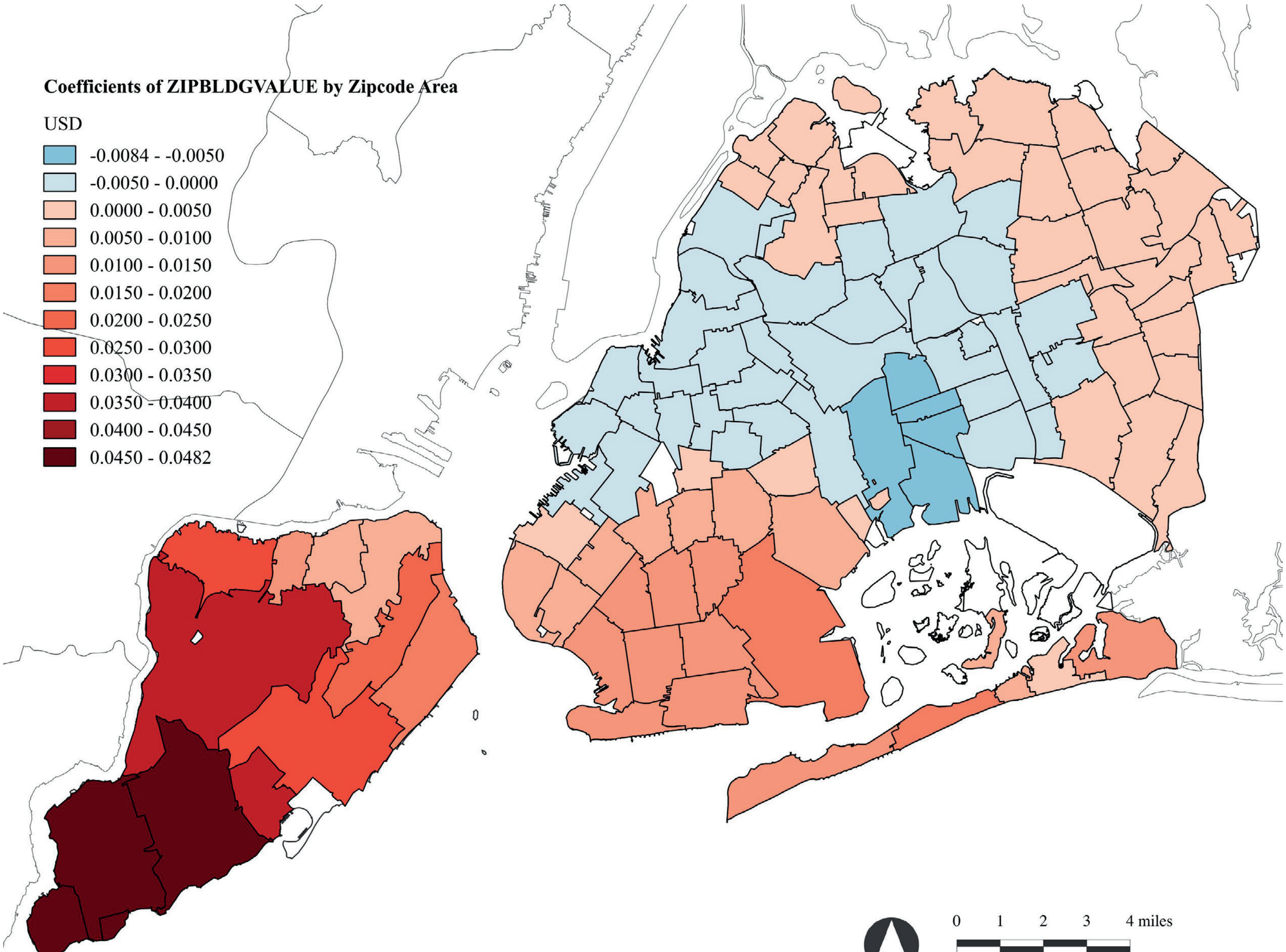

Figure A-9. Distribution of Coefficient of *ZIPBLDGVALUE* by Zipcode Area

10) Local R-Square

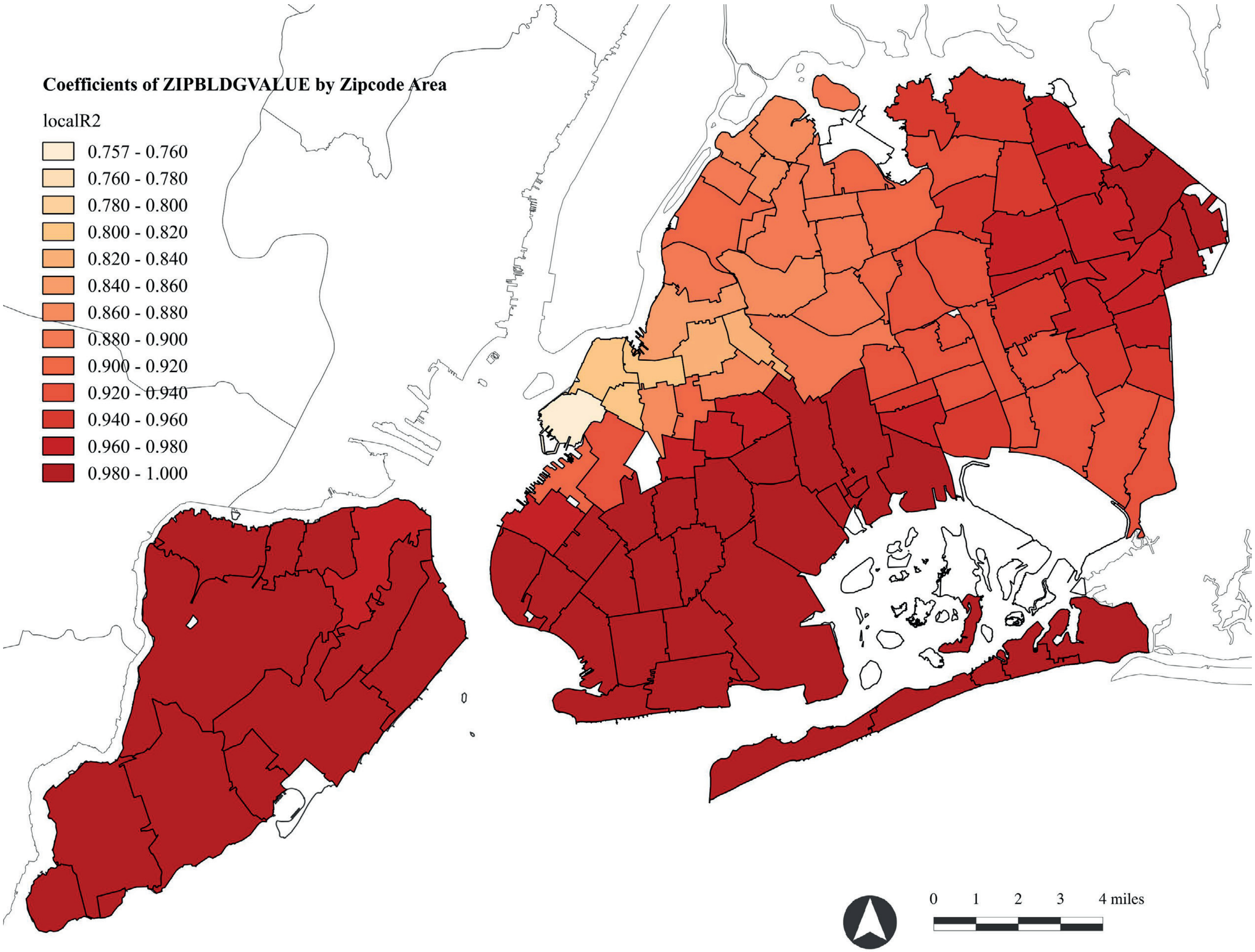

Figure A-10. Distribution of Local R-Square by Zipcode Area